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Richard Wozniak, M.D.

**CONTRACTING ORGANIZATION:**

Conemaugh Valley Memorial Hospital  
Johnstown, PA 15905

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14. ABSTRACT The MIDHT project continues to implement and research health information technologies (HIT) within the Conemaugh Health System, located in Southwestern Pennsylvania. Core technologies under investigation include pharmacy robotics, bar code medication administration (BCMA) and health information exchange via the eHealth Exchange. Statement of work is being delivered as expected.  Significant progress has been made on both arms of the project. Research activities for Arm 1 have progressed, including an initial analysis on medication errors and completion of statistical testing on nursing workflow and satisfaction. Conemaugh is participating in the 14 <sup>th</sup> Virtual Lifetime Electronic Record pilot nationwide via data exchange with the Altoona VA Medical Center (Arm 2). Patient correlations, system users and document exchanges all have increased throughout the year. Conemaugh was the first participant in the nation to pass the new "eHealth Exchange" testing program (2010/2011 services).					
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## ***Introduction***

The Military Interoperable Digital Hospital Testbed (MIDHT) is a six-year program of research to develop a real-world testbed environment in Southwestern Pennsylvania. The purpose is to research and evaluate Health Information Exchange (HIE) and health information technology (HIT) and services (HITS) that make health information readily available to consumers and providers. Ideally this will allow for the secure transfer of information between private sector rural providers, federal partners and patients. MIDHT has defined requirements and solutions to optimize healthcare resources for rural communities and identified lessons learned and best practices that benefit both the global Military Health System (MHS) environment and stakeholders in the local region. The Department of Defense (DoD) and Conemaugh Memorial Medical Center (CMMC) have common requirements for HIE, connecting disparate systems and providers and enabling secure provider-provider and provider-consumer e-communications. Minimal evidence is available on what business, clinical and technical solutions can be used to overcome the lack of specialists, infrastructure and geographical barriers associated with the delivery of care in rural communities.

### **Arm 1. The Impact of Medication Dispensing/Administration Technology Within a Rural Healthcare System.**

In order to improve efficiency and safety of medication dispensing and administration within an inpatient hospital setting, a complementary set of health information technologies have been implemented. A centrally managed pharmacy robotics system implemented in 2011 works in conjunction with bar coded medications administered at the bed side on many units at CMMC and Meyersdale Medical Center (MYMC). Research activities have focused on medication errors, provider workflow, provider satisfaction and financial data.

### **Arm 2. Health Information Exchange (HIE) via the Nationwide Health Information Network (NwHIN).**

Building upon work completed the previous year, CMMC continued efforts on health information exchange using the eHealth Exchange (formerly NwHIN) standards and specifications. CMMC has been in production with the James E. Van Zandt VA Medical Center in Altoona, PA for one year as part of the 14<sup>th</sup> Virtual Lifetime Electronic Record (VLER) pilot in the United States. CMMC has made tremendous strides in a number of activities, including a CONNECT gateway upgrade, testing certification, training additional providers and increasing the number of correlated patients.

CMMC received a formal contract modification on August 26, 2013. The modification extended the contract at no-cost for one year through October 27, 2014 and also included a revised budget (dated May 2, 2013). CMMC's subcontract with Northrop Grumman will expire on September 30, 2013.

## ***Body***

### **Arm 1: The Impact of Medication Dispensing/Administration Technology Within a Rural Healthcare System**

Subtask 1.1 Implement pharmacy robotic technology and bar-coded enabled medication administration (BCMA) in an acute hospital system setting.

#### Pharmacy Robotics / Bar Code Medication Administration (BCMA)

##### **MedCarousel2 Implementation - CMMC**

CMMC finalized the second MedCarousel dispensing system placement in the centralized pharmacy (see diagram in Appendix 1). CMMC worked with an outside engineering firm to prepare documents that were submitted to the PA Department of Health in January 2013 for approval before physical accommodation work began. The amount of site work required was much less than with first MedCarousel due to the fact that the second unit was not as tall as the first one and would not protrude through the ceiling. Floor support was the main required change.

The second MedCarousel implementation was implemented in the pharmacy on April 8, 2013 (Figure 1. MedCarousel 2.). CMMC streamlined the manual pick processing that occurs when a medication is not able to be stocked in the robot. This also has helped reduce the number of open bulk medication bottles and decrease inventory slightly because of increased efficiency. The second MedCarousel has also helped with the picking processes since of the oral medications are located in the MedCarousel. The barcode system is fully engaged and ensures patient safety each time a medication is removed from the MedCarousel. Technician time is better spent doing other tasks than searching for a missing medication. The second MedCarousel has helped CMMC achieve a better work flow pattern in the drug distribution area.

The additional MedCarousel has also helped with the ordering and restocking of inventory when it arrives within the department from the manufacturer. With barcode scanning, CMMC can ensure that the medication is in its proper place when being restocked. As with the first MedCarousel, PAR levels are setup to help keep inventory levels sufficient to meet patient needs.



**Figure 1. MedCarousel 2 in pharmacy.**

McKesson has installed the BCMA Analytics feed into Conemaugh's performance management system called HBI. The Decision Support department conducted user training for nurse managers and directors on the use of HBI to interact directly with the BCMA data. This is a very rich analytics tool and once trained, nurse leaders are able to drill into the data to identify specific staff, nurse stations, and medications that require follow-up and possible re-training. Screenshots located in Appendix 2 provide a look and feel of the BCMA highlights via HBI and the different customizable view levels (by unit, by med, by staff, etc.).

### **Medication Delivery Process - CMMC**

Under the current process, paper envelopes are delivered to nursing units each day. Nursing then must transfer the medications from the envelopes into the plastic bins housed in the computerized med carts. Unused medications are returned back to the pharmacy in the same envelopes. This process has created extra steps for nursing and thus has been identified as an area of dissatisfaction. Additionally, since the envelopes are re-used as a cost saving strategy, the extra handling associated with this process leads to the envelopes becoming damaged. This,

in turn, contributes to dispensing malfunctions from the robot. The Pharmacy department has since worked closely with nursing to pilot a new “exchange bin” method of delivering medications to inpatient units. In this workflow, nursing gets patient-identified plastic bins with the robot-filled medications from the current day. These bins are exchanged with bins from the preceding day for the same patient in the med cart. The expected advantages are: 1. Envelopes never leave the pharmacy so they are much less likely to get mis-handled and damaged (saves cost) 2. Nursing does not have to transfer meds from envelope to bin and then transfer unused meds from bin to envelope (less chance for error). Feedback from the first two pilot units has been positive. During the next quarter, Pharmacy anticipates to recommend full adoption of this process to nursing leadership. We are still working with Rubbermaid to finalize the pricing quote and purchase order.

### Overall BCMA Deployment - CMMC

Table 1 demonstrates the number of medication administration attempts, medications given and the total administrations using barcode scanning during the last three months. BCMA utilization continues to run at 95%. As seen in Table 1, the difference between medication administration attempts and the actual medication given may be due to the following reasons, including patient refusal or a vital sign/laboratory parameter exceeding protocol administration range.

Month Medication was Charted	Total Med Admin Attempts	Given	% Given	Barcode Scanned Count	% Barcode Scanned
Apr-13	160,314	134,946	84.2%	127,571	94.5%
May-13	177,850	150,901	84.8%	142,829	94.7%
Jun-13	120,492	102,227	84.8%	97,222	95.1%
<b>Total</b>	<b>458,656</b>	<b>388,074</b>	<b>84.6%</b>	<b>367,622</b>	<b>94.7%</b>

Table 1. BCMA Adoption.

### Miners BCMA Deployment

In May, Miners Medical Center’s (MIMC) pharmacy medication master file was successfully synchronized with that of Memorial/Meyersdale’s. A single medication master file now serves all three Conemaugh hospitals. This was a multi-month effort that completed a key prerequisite to implementing BCMA at Miners. As this task was completed, the MIS Clinical Analysts began the order build process. Meetings were held at the Miners facility with nursing and ancillary staff to design the workflow process. The system build is underway (approximately 50% complete). Upon completion of the build, a thorough system test will take place. Planning and implementation of user training is scheduled to occur in the next quarter. MIS worked with MiMC Nursing Administration to identify super users to facilitate BCMA training and on-site support, similar to the process used for the Memorial implementation. MIS recruited the services of several nursing super users to dedicate time to these tasks. BCMA deployment at Miners has been delayed due to implementation of the McKesson ER12 upgrade and is scheduled for the first quarter of calendar year 2014.

### School of Nursing BCMA Deployment

Conemaugh staff finalized the School of Nursing device needs for student nurses in November 2012. Additional Rubbermaid medication carts were deployed in December 2012 after receipt from vendor. The primary purpose was to improve student exposure to the current BCMA process and enhance the learning experience.

### Subtask 1.2 Research and analyze the resulting technological impact on medication errors, pharmacist productivity, nurse satisfaction/workflow and patient satisfaction.

#### Nursing Surveys at CMMC & MYMC

A total of 25 CMMC nurses completed the survey during the reporting period. The survey was closed on October 5, 2012. Final statistical analysis has been completed for the CMMC dataset. The addition of 25 surveys did not change the results and conclusions of the non-pairwise analysis (one-way ANOVA) reported in the 2012 Annual Report.

The pairwise (same person completing survey at multiple time points) analysis is as follows:

A repeated-measures analysis of variance (RM-ANOVA) was completed between Baseline and Post 1 and Baseline and Post 2 periods over the same questions as were analyzed for the one-way ANOVA. The Sidak formula was used to adjust for multiple comparisons. Overall alpha (family-wise) remained at 0.05. These results support the conclusions of non-pairwise analysis. Unfortunately respondent error with creation of the "SUM" ID and a lack of trust by nurses in order to protect their identity prevented a higher sample size.

Time Periods	Question	Later time - baseline	Mean Difference over TIME	p-value	Correction for non- sphericity
Baseline and Post 1, N = 35	Q30	decrease	-1.143	0.008	
	Q04			NS	
	Q05			NS	
	Q06			NS	
	Q07	decrease	-0.788	0.011	Univariate results, Greenhouse-Geisser
	Q13			NS	
	Q15			NS	
	Q18			NS	
Baseline and Post 2, N = 26	Q30			NS	
	Q04	increase	0.846	0.023	Univariate results, Greenhouse-Geisser
	Q05			NS	

	Q06			NS	
	Q07	decrease	-0.808	0.034	Univariate results, Greenhouse-Geisser
	Q13			NS	
	Q15	increase	0.192	0.019	Univariate results, Greenhouse-Geisser
	Q18			NS	

NS = No Significance

**Table 2. Repeated- Measures ANOVA.**

Q30: Overall, how satisfied are you with the current medication administration system?

Answer Choices: 1 = Completely Dissatisfied <> 5 = neither <> 10 = Completely Satisfied

- ◆ means, Baseline = 5.63; Post 1 = 4.49
- ◆ The results above indicate a statistically significant decrease in satisfaction of BCMA from baseline to post 1.

*A 6-point Likert scale was used for the remaining questions under analysis:*

1 Strongly Agree	3 Slightly Agree	5 Moderately Disagree
2 Moderately Agree	4 Slightly Disagree	6 Strongly Disagree
0 NA Not Applicable		

*Please refer to the tables below for quantification of the mean score for the following questions by time period.*

Q04: Because of information available through the current medication administration system I know both the intended actions and side effects of medications I administer.

- ◆ The results above indicate a statistically significant improvement of perception of knowledge after implementation of BCMA as compared to baseline.

Q07: The current medication administration system provides me with information to know that a medication order has been checked by a pharmacist before I administer the medication.

- ◆ The results above indicate a statistically significant decrease in the perception of the knowledge that the medication order has been checked by a pharmacist before administration by the nurse after implementation of BCMA as compared to baseline.

Q15: The current medication administration system is effective in reducing and preventing medication errors.

- ◆ The results above indicate a statistically significant improvement of perception of the effectiveness of BCMA to reduce and prevent medication errors as compared to baseline.

Descriptive Statistics: Baseline( 1) – Post 1 ( 2)				Descriptive Statistics: Baseline( 1) – Post 2 ( 3)			
	Mean	Std. Deviation	N		Mean	Std. Deviation	N
Q07 1	2.94	1.694	33	Q04 1	2.73	1.589	26
Q07 2	2.15	.906	33	Q04 3	3.58	1.901	26
				Q07 1	3.31	1.436	26
				Q07 3	2.50	1.273	26
				Q15 1	3.65	1.231	26
				Q15 3	3.00	1.497	26

Table 3. Descriptive Statistics.

The second POST survey was distributed to nursing staff at MYMC in early January 2013. A total of 17 surveys were completed within four weeks, with two of those surveys not 100% complete so the sample size varies from 15-17 depending on question.

Below are the final results for all three survey distributions at Meyersdale:

Responses to Questions 4-19 and 23-29 were coded 0 – 6, inclusive, with the following meaning:

0 = N/A (not applicable)	
1 = Strongly Agree	4 = Slightly Disagree
2 = Moderately Agree	5 = Moderately Disagree
3 = Slightly Agree	6 = Strongly Disagree

Q30 was coded from 1 – 10 with a between response interval = 1, where:

*1 = completely dissatisfied, 5 = neither satisfied/dissatisfied, 10 = completely satisfied*

These response scales are ordinal and approximately interval. In order to take advantage of the more powerful parametric tests, the scale has been assumed continuous. As this is an assumption for analysis only, non-parametric tests were also applied to check consistency of the analysis.

The following analyses are between-group, pre vs. post 1 vs. post 2 study time periods, with a family-wise alpha criteria = 0.05. When homogeneity of variances held, the Bonferroni correction was applied for pairwise comparisons; when not, Games-Howell was used.

#### Survey Section 3: Q04-08

Homogeneity of variances (over study time periods) held for all questions.

Only Q04 showed a statistically significant omnibus ANOVA, p-value = 0.024. The pairwise results follow and show significant results between the pre and post 1 periods, p-value = 0.037.

#### Multiple Comparisons

Bonferroni			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
Dependent Variable	(I) Study Time Period	(J) Study Time Period				Lower Bound	Upper Bound
S3 Q04: Because of information available through the current medication administration system I know both the intended actions and side effects of medications I administer.	PRE (before BCMA) <i>N</i> <sub>PRE</sub> = 19	Post 1 (BCMA stabilization)	-1.498 <sup>*</sup>	.579	.037	-2.93	-.07
		Post 2 (BCMA)	-1.480	.641	.073	-3.06	.10
	Post 1 (BCMA stabilization) <i>N</i> <sub>Post 1</sub> = 26	PRE (before BCMA)	1.498 <sup>*</sup>	.579	.037	.07	2.93
		Post 2 (BCMA)	.018	.599	1.000	-1.46	1.49
	Post 2 (BCMA) <i>N</i> <sub>Post 2</sub> = 17	PRE (before BCMA)	1.480	.641	.073	-.10	3.06
		Post 1 (BCMA stabilization)	-.018	.599	1.000	-1.49	1.46

\*. The mean difference is significant at the 0.05 level.

Table 4. Question 4 Statistical Results.

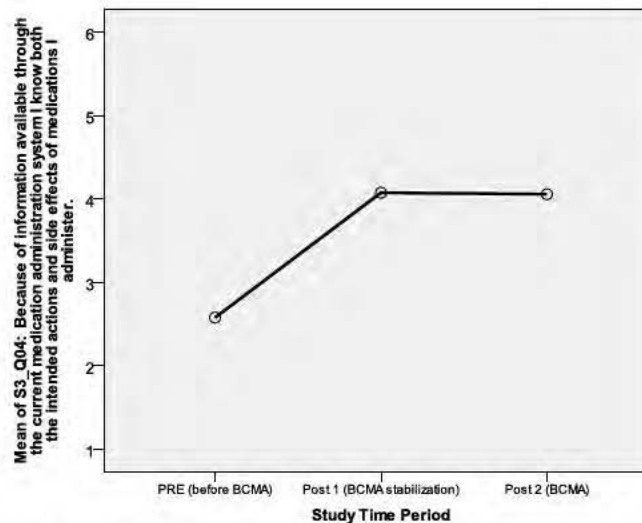


Figure 2. Graphical Representation of Question 4 Results.

#### Survey Section 4: Q09-19

Homogeneity of variances (over study time periods) held for all questions except Q12 and Q13.

The following questions showed a statistically significant omnibus ANOVA:

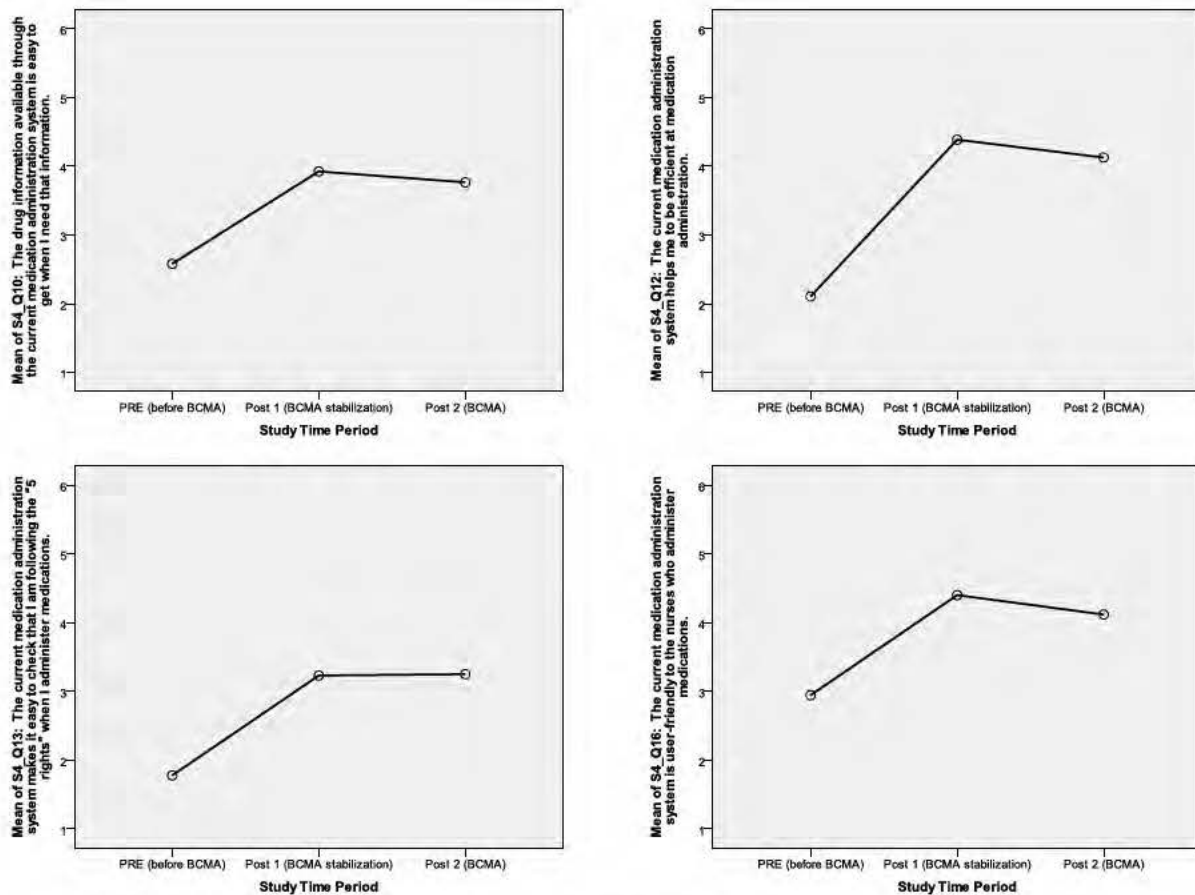
Question	p-value	N,PRE	N,Post 1	N,Post 2
Q10	0.028	19	26	17
Q12	<0.0005	19	26	16
Q13	0.020	18	26	16
Q16	0.025	18	25	17

The pairwise results follow and show significant results between:

Question	p-value	pairwise study time periods
Q10	0.033	PRE and Post 1
Q12	<0.0005	PRE and Post 1
	0.003	PRE and Post 2
Q13	0.008	PRE and Post 1
	0.048	PRE and Post 2
Q16	0.017	PRE and Post 1

Multiple Comparisons							
Dependent Variable		(I) Study Time Period	(J) Study Time Period	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound Upper Bound
S4_Q10: The drug information available through the current medication administration system is easy to get when I need that information.	Bonferroni	PRE (before BCMA)	Post 1 (BCMA stabilization)	-1.344	.512	.033	-2.60 -.08
			Post 2 (BCMA)	-1.186	.566	.121	-2.58 .21
		Post 1 (BCMA stabilization)	PRE (before BCMA)	1.344	.512	.033	.08 2.60
			Post 2 (BCMA)	.158	.529	1.000	-1.14 1.46
		Post 2 (BCMA)	PRE (before BCMA)	1.186	.566	.121	-.21 2.58
			Post 1 (BCMA stabilization)	-.158	.529	1.000	-1.46 1.14
S4_Q12: The current medication administration system helps me to be efficient at medication administration.	Games-Howell	PRE (before BCMA)	Post 1 (BCMA stabilization)	-2.279	.457	.000	-3.39 -1.17
			Post 2 (BCMA)	-2.020	.544	.003	-3.38 -.66
		Post 1 (BCMA stabilization)	PRE (before BCMA)	2.279	.457	.000	1.17 3.39
			Post 2 (BCMA)	.260	.614	.906	-1.25 1.77
		Post 2 (BCMA)	PRE (before BCMA)	2.020	.544	.003	.66 3.38
			Post 1 (BCMA stabilization)	-.260	.614	.906	-1.77 1.25
S4_Q13: The current medication administration system makes it easy to check that I am following the "5 rights" when I administer medications.	Games-Howell	PRE (before BCMA)	Post 1 (BCMA stabilization)	-1.453	.456	.008	-2.56 -.34
			Post 2 (BCMA)	-1.472	.579	.048	-2.93 -.01
		Post 1 (BCMA stabilization)	PRE (before BCMA)	1.453	.456	.008	.34 2.56
			Post 2 (BCMA)	-.019	.656	1.000	-1.64 1.60
		Post 2 (BCMA)	PRE (before BCMA)	1.472	.579	.048	.01 2.93
			Post 1 (BCMA stabilization)	.019	.656	1.000	-1.60 1.64
S4_Q16: The current medication administration system is user-friendly to the nurses who administer medications.	Games-Howell	PRE (before BCMA)	Post 1 (BCMA stabilization)	-1.456	.504	.017	-2.68 -.23
			Post 2 (BCMA)	-1.173	.552	.101	-2.53 .19
		Post 1 (BCMA stabilization)	PRE (before BCMA)	1.456	.504	.017	.23 2.68
			Post 2 (BCMA)	.282	.575	.876	-1.12 1.69
		Post 2 (BCMA)	PRE (before BCMA)	1.173	.552	.101	-.19 2.53
			Post 1 (BCMA stabilization)	-.282	.575	.876	-1.69 1.12

Table 5. Questions 10, 12, 13 & 16 Statistical Results.



**Figure 3. Graphical Representation of Questions 10, 12, 13 & 16 Results.**

### Survey Section 7: Q23-29

Homogeneity of variances (over study time periods) held for all questions.  
No questions showed a statistically significant omnibus ANOVA.

Question 30: Overall, how satisfied are you with the current medication administration system?

Homogeneity of variances (over study time periods) held for this question. This question showed a statistically significant omnibus ANOVA,  $p\text{-value} = 0.023$  and indicates a trend of increasing dissatisfaction from pre to post time periods. Figure 4 shows the dissatisfaction at MYMC (rural facility) was slightly worse than the flagship hospital, Memorial, with a greater disparity in satisfaction at MYMC. Please note the sample sizes were drastically different.

The pairwise results follow:

		Multiple Comparisons		Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
Dependent Variable		(I) Study Time Period	(J) Study Time Period				Lower Bound	Upper Bound
S_Q30: Overall, how satisfied are you with the current medication administration system?	Bonferroni	PRE (before BCMA) N,PRE = 17	Post 1 (BCMA stabilization)	1.762	.727	.056	-.03	3.56
			Post 2 (BCMA)	2.082 <sup>*</sup>	.819	.042	.06	4.11
		Post 1 (BCMA stabilization) N,Post 1 = 25	PRE (before BCMA)	-1.762	.727	.056	-3.56	.03
			Post 2 (BCMA)	.320	.755	1.000	-1.55	2.19
		Post 2 (BCMA) N,Post 2 = 15	PRE (before BCMA)	-2.082 <sup>*</sup>	.819	.042	-4.11	-.06
			Post 1 (BCMA stabilization)	-.320	.755	1.000	-2.19	1.55

\*. The mean difference is significant at the 0.05 level.

Table 6. Question 30 Statistical Results.

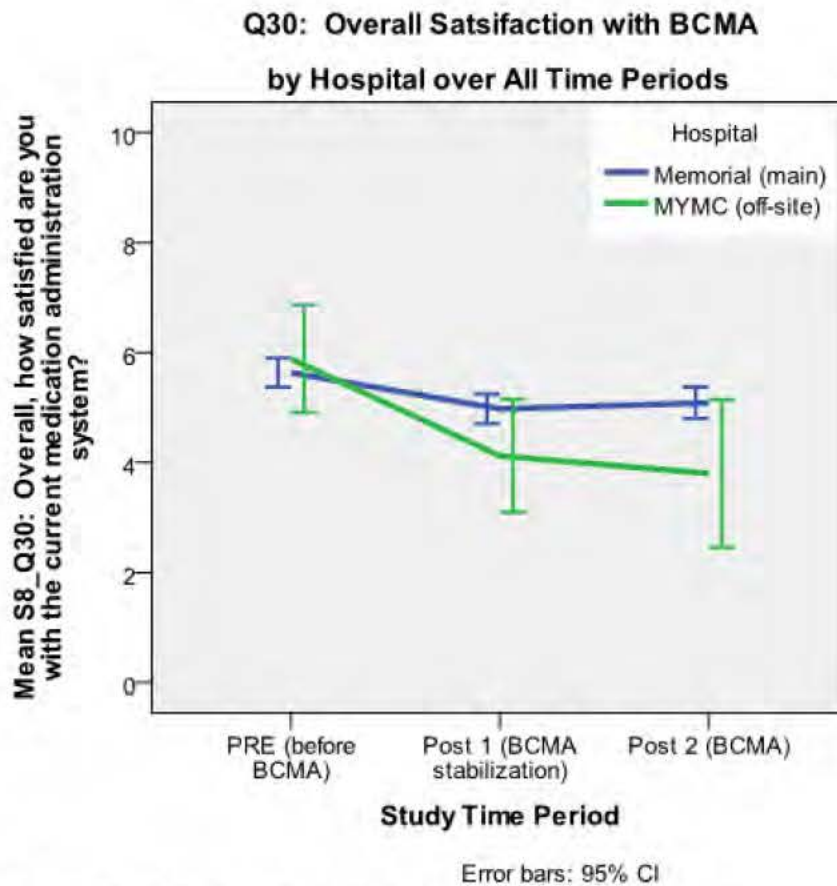
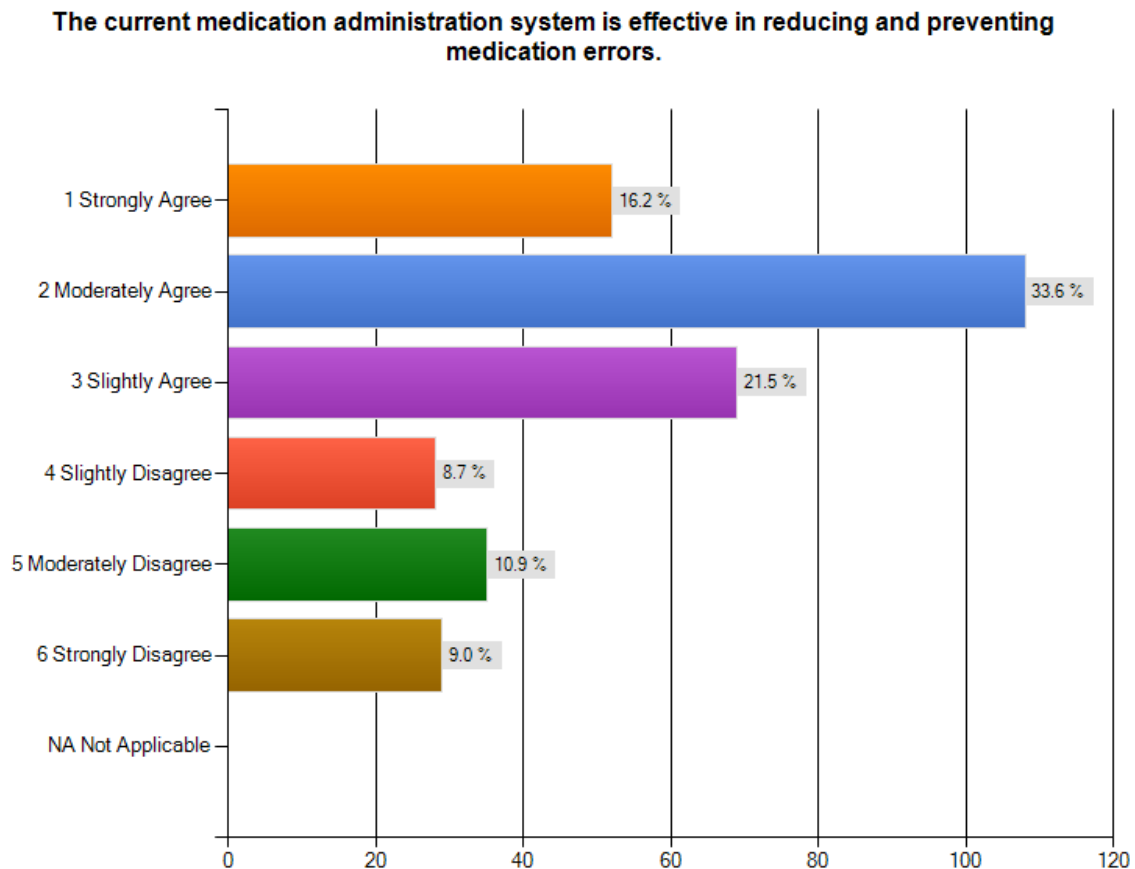


Figure 4. Overall satisfaction with BCMA by hospital over all time periods.

Despite the overall dissatisfaction of the BCMA system, a majority of nurses (71%) agreed in Figure 5 positively that the system was effective in reducing and preventing medication errors. These qualitative results will be considered in regards to the quantitative analysis of error counts/rates.



**Figure 5. Nurse opinion on BCMA reducing and preventing medication errors, POST 2.**

The survey asked the respondents to input a unique code ("SUM") so that related-samples analysis could be performed over the three time periods, baseline, Post 1, and Post 2.

Unfortunately, too few respondents followed the instructions or were employed during all time points. Only six responses were common between baseline and Post 1, seven between baseline and Post 2, and two over all three time periods. This sample size does not meet the generally accepted threshold of ten for analysis to be undertaken.

The electronic survey was communicated internally with staff at MYMC and a link was made available on the MYMC Intranet page in early January 2013 (POST 2). The validated survey instrument by Hurley et al. (see Appendix 3) was identical to the one conducted at the flagship Memorial Medical Center. A total of 17 surveys were completed within four weeks, with two of those not 100% complete. Data was collected at three different time points, PRE (baseline - 2011), POST 1 (3 months POST BCMA – 2012), and POST 2 (8 months POST BCMA). Statistical

analysis was then performed on the combined dataset over all three time periods. Tables 4-6 and Figures 2-4 present the survey results as indicated. Sample sizes are generally as follows but may vary by question; N = 17 (PRE), N = 26 (POST 1) and N = 15 (Post 2).

Please note that the positively sloped trend lines in Figure 2 and 3 indicate increasing dissatisfaction with the BCMA system per the ordinal response scale used in the survey instrument, refer to Appendix 3.

In conclusion, nursing staff at MYMC is less satisfied with the new BCMA system than the previous manual medication administration system. The second post survey results indicate that satisfaction continued to decline, which is surprising because most users and system effectiveness should be past the learning curve phase at this point. On the other hand, these results are not surprising because users are likely a close-knit group located in a small, rural facility and may be resistant to technological advances. As demonstrated by the comments in Table 7, various issues are present and contributing to their dissatisfaction.

Comments added in response to open-ended survey questions during the Post time periods have been summarized in Table 7 below:

<b>Issue</b>	<b>Count</b>
System not user friendly	11
Medication profile errors	6
Barcodes not scanning	4
Dangerous system	4
Communication problems between pharmacy and nursing	3
Medications not easy to find	2
Easier way to check med orders	2
Medication info not contained within application	1
Takes too long to pass medications	1
Timeliness of drugs dispensed	1

**Table 7. Summary of Comments Received.**

### Physician eMAR Survey - CMMC

Given the low sample size (n=9) from the first announcement, a second announcement of the survey was sent to CMMC physicians, residents and physician assistants in late November 2012. A modest response was received during the first quarter, which included 30 new surveys. The current sample size of 39 represents 8% of the medical and resident staff. Below are descriptive results for a few key questions; statistical analysis is pending.

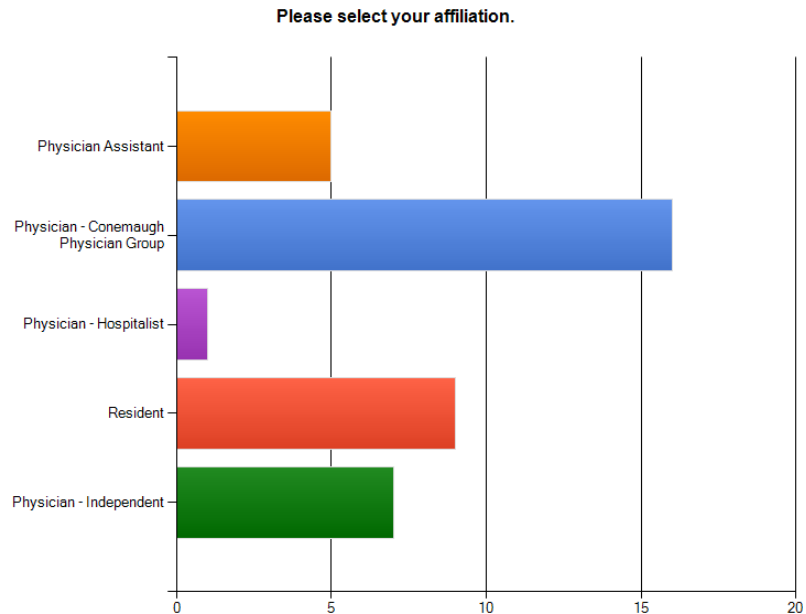


Figure 6. Physician Affiliation.

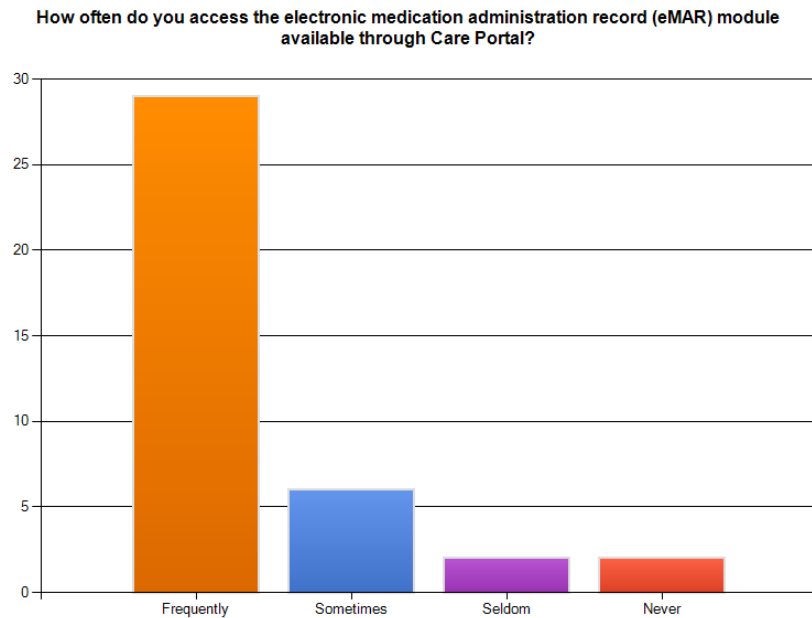


Figure 7. Access to eMAR module.

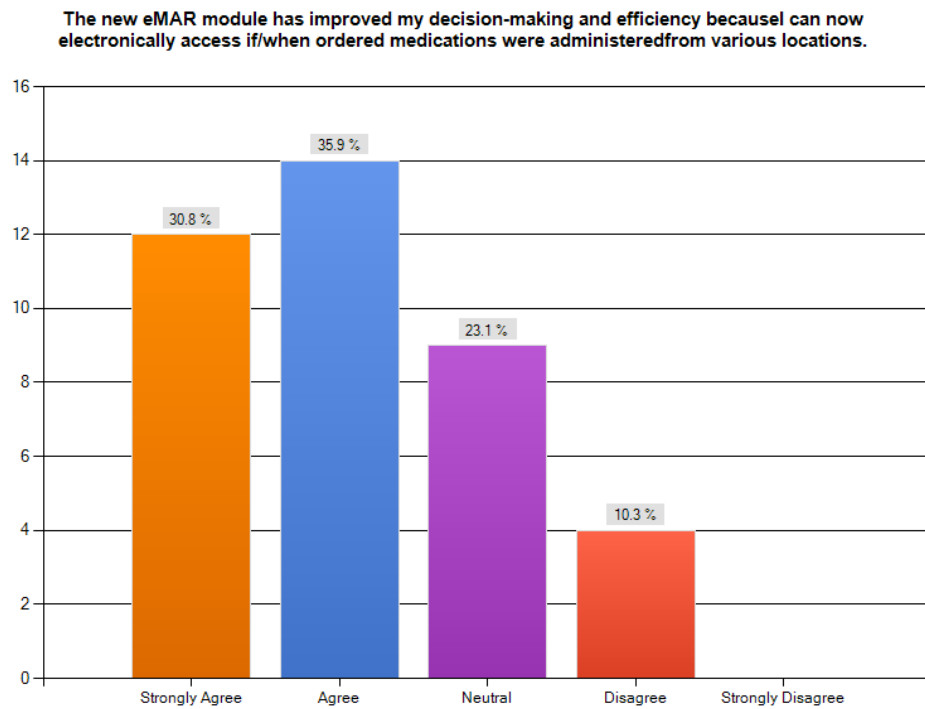


Figure 8. Improved decision-making via eMAR.

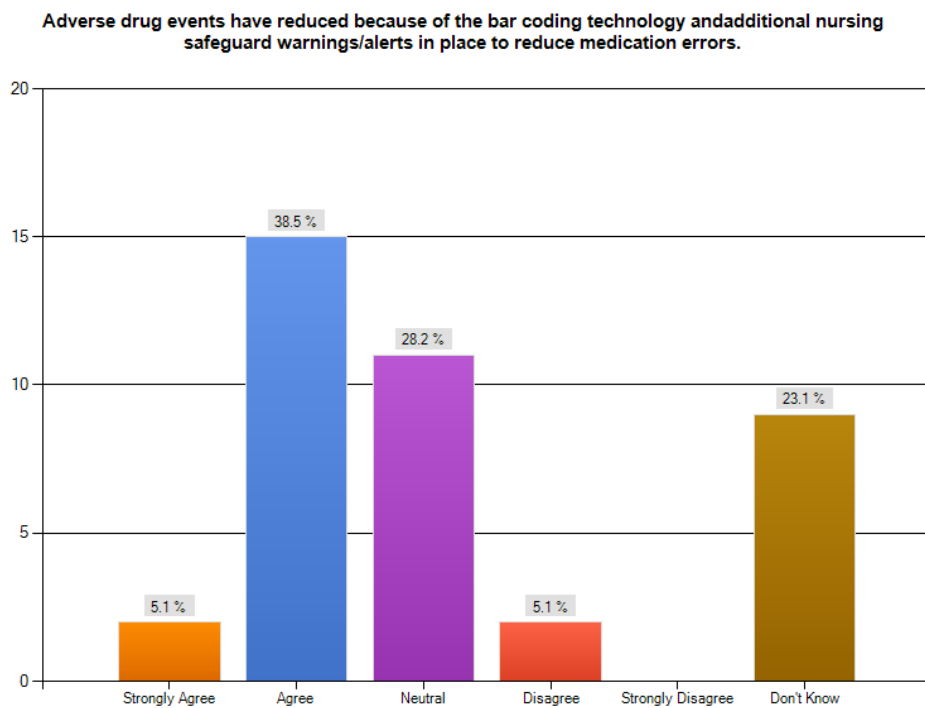


Figure 9. Physician perspective on reduction in adverse drug events.

### Interim Medication Error Analysis - CMMC

The research team completed intensive review of all CMMC medication events as reported in the Quantros SRM event/incident reporting system. Researchers reviewed over 1,100 written incident summaries in detail and logically determined the impact on the MIDHT study using the nature of the error and when (phase) it occurred (“Applicability”). The PRE-BCMA time period is November 2010 – October 2011. The POST-BCMA time period is from November 2011 – January 2013. The additional three months was needed because of the phased BCMA deployment schedule at CMMC. All errors that occurred within a unit/department that has not deployed BCMA technology were removed from the dataset.

The influence of the MIDHT intervention on medication errors from before implementation, PRE, versus after implementation, POST, was investigated using the Pearson Chi-squared test. Fisher’s Exact Test was employed as required, e.g. when the count of any cell in the crosstab being analyzed was less than 5. The ordinal variable, Study Time Period, was treated as the independent variable (IV). It has only two levels, PRE and POST, both which contain 12 months of data for each clinical unit. The statistical testing was applied in a stepwise manner relative to the variables treated as dependent. The dependent variables are as follows:

Variable Name	Variable Type	Levels
Error Disposition	nominal	Near Miss
		Actual
MIDHT Applicability	nominal	Yes
		No
PHASE	ordinal	ORDER (1 <sup>st</sup> )
		PROFILE (2 <sup>nd</sup> )
		DISPENSE (3 <sup>rd</sup> )
		ADMINISTRATION (4 <sup>th</sup> )
		Other
Core Problem (Med. Error) Type	nominal	Please see Table 10 for a detailed listing

**Table 8. Variable Name Description.**

The stepwise analysis began with testing each of the dependent variables separately. The results were:

Crosstab	Chi-squared, $\chi^2$	df	Sample size, N	p-value, asymp. sig. (2-sided)
Error Disposition * Study Time Period	18.43	1	1,101	< .001 <b>a</b>
MIDHT Applicable * Study Time Period	4.86	1	1,101	.027 <b>a</b>
PHASE * Study Time Period	11.39	1	1,101	.023
Core Problem (Error) Type * Study Time Period	180.77	21	1,101	< .001

**a.** Continuity correction applied

**Table 9. Crosstab inferential results.**

Sidak's correction for multiple testing was applied which reduced the testwise alpha criterion to 0.017. This correction is slightly conservative in that no correlation is assumed to exist among the variables. A correlation analysis of (between) the dependent variables revealed an average correlation of 0.1, which rises slightly to 0.3 if only the statistically significant correlations are averaged. Including the 0.3 correlation into the calculation of Sidak's correction yields a testwise alpha criterion to 0.019 and corresponding critical z-value for 2 sided testing:  $\geq 2.3407$  (critical z-value for 1 sided testing:  $\geq 2.0695$ ). Therefore, only Error Disposition \* Study Time Period and Core Problem (Error) Type \* Study Time Period crosstabs have a statistically significant result.

Core Problem (Med Error) Type
Bar Coding/Scanning Error
Charting Error
Drug Delay
Drug Location Issue
Drug Not Ordered
Drug Omitted
Drug Protocol/Policy Not Followed
Incorrectly Stamped Order Sheet
IV Related Issue
Medication Reconciliation Issue
Order Issue
Patient Not Compliant
Pharmacy Profile Error
Pyxis Issue
Wrong Dose
Wrong Drug
Wrong Frequency
Wrong Label
Wrong Patient
Wrong Quantity
Wrong Route

**Table 10. Medication Error Type Listing.**

These interim results indicate that Error Disposition and Study Time Period are not statistically independent over the entire dataset of medication errors; therefore differences in error disposition are related to the difference in Study Time Period. Standardized residuals of the crosstab revealed that cells of the levels of Near Miss for both Pre and Post contributed to the significant chi-square result. Collectively, this implies that the total of Near Miss errors (whether MIDHT Applicable or not) increased from PRE to POST. The standardized residuals for Actual errors indicate no contribution to the chi-square significance, which implies no statistically significant difference between time periods. Given this the statistically significant result for the crosstab of Error Disposition \* Study Time Period, a more detailed analysis was performed on a stratified crosstab of Error Disposition by MIDHT Applicability versus Study Time Period. No statistical significance was found for MIDHT Applicability on either level of Error Disposition.

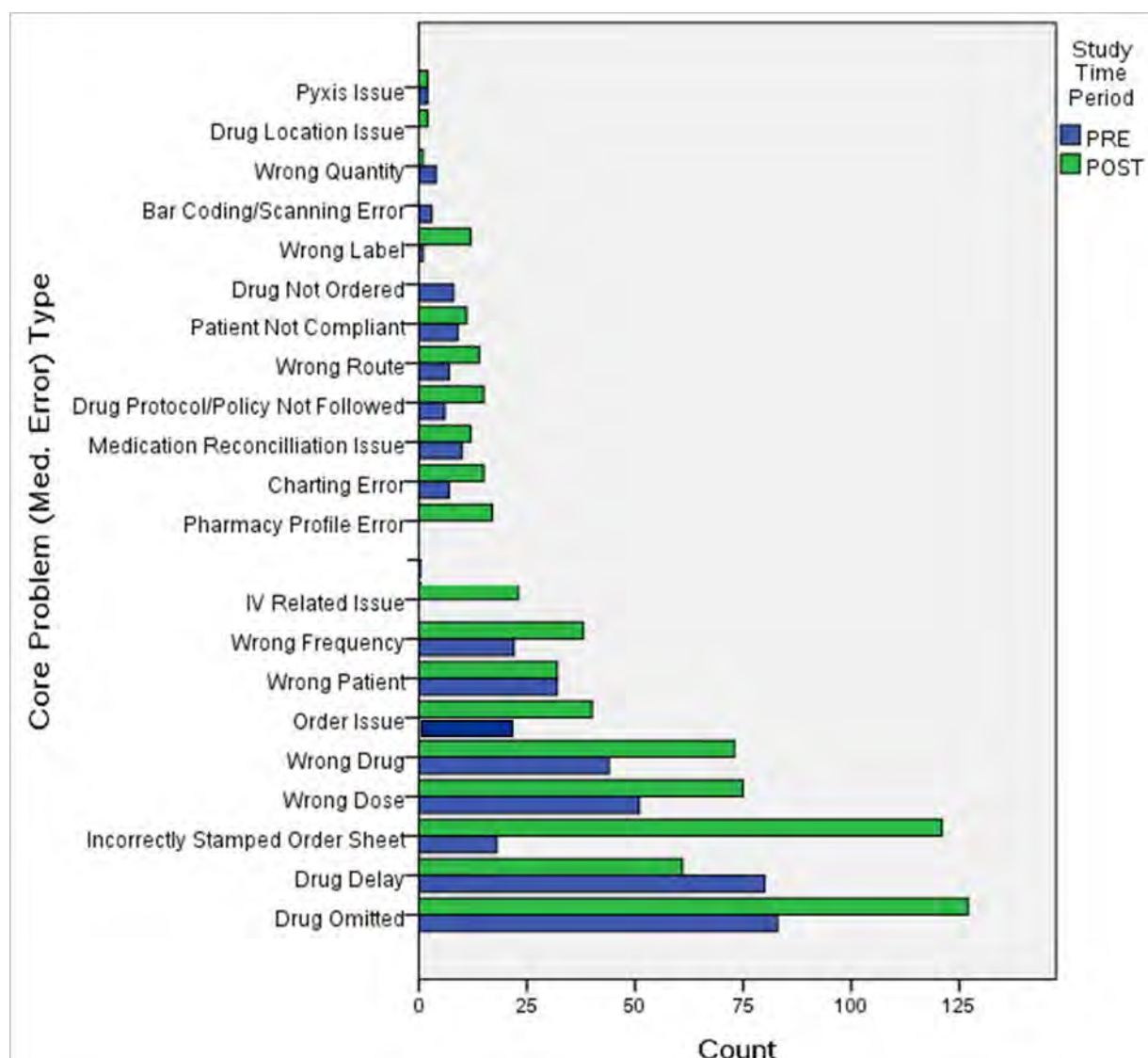
The interim results indicate that the distribution of Core Problem (Error) Type differs over Study Time Period. The standardized residuals reveal the following variables contribute to that difference:

	Implication regarding change from PRE to POST
Drug Delay	decrease
Order Issue	increase
Incorrectly Stamped Order Sheet	increase

Note that the implications drawn from the Core Problem (Error) Type \* Study Time Period chi-squared analysis are with caution because:

- 10 cells (22.7%) of the 22 by 2 crosstab have an expected count less than 5
- 14 cells have an observed count < 5
- 14 cells have an observed count < 10

**Table 11. Standardized residual results.**



**Figure 10. Medication Error Type by Period.**

Common errors, such as wrong patient, wrong drug, and wrong dose all had a somewhat neutral change from PRE to POST. Either the frequency of each medication error type is so low that no significant change is detected or the error can be attributed to human error and therefore not affected between time periods. The culture of reporting errors had changed in the POST period, which complicates this analysis.

The medication administration process is not simply the act of administering medication, but rather complex processes involving multiple steps from numerous disciplines, departments, and users. Errors can appear at one, some, or even all stages between the medication order process (prescription) through the actual administration of the medication and/or possible adverse events. Though a specific error may occur prior to a patient receiving the medication, most errors are noted only once the medication is incorrectly administered at the bedside.

Despite the fact that BCMA strives to assure the “five rights” of medication administration – right patient, right route, right drug, right dose, and right time, most studies however have investigated the effect of BCMA on the rate of severity of the errors or the effect of the BCMA on the duration of administering medication.

Medication errors can vary depending on the differing levels of care per hospital floor. A recent literature review study <sup>1</sup>(Hassink, 2012) reports average baseline error frequency rates from 5.8-25.3% (1.6-27.8% if error times were excluded). Wrong time errors are generally considered to be less severe. Typical reports after BCMA implementation include a 30-50% reduction in medication errors, but only when time errors are excluded. For this interim data analysis medication errors are only listed as counts, rather than error rates. The final study report will include more detailed and more comparable analyses on rates.

The severity of drug errors will also be addressed in the final study report. Some studies have reported a nearly 50% reduction in risks post BCMA implementation <sup>2 3 4</sup>(Poon, 2010; Franklin, 2007; Morris, 2009). Error disposition (i.e. near miss or actual miss) per time periods, nursing unit, and other appropriate delineations may lead to subsequent conclusions about BCMA implementation. Initial discussions were rooted in the possibility that reporting frequency of actual vs near miss may differ (e.g. near miss may be reported less frequently to save time; or near miss errors may be reported more POST BCMA implementation because nurses were disgruntled/dissatisfied with the technology and/or disruptions to their traditional workflow, PRE implementation). The final study report will include more detailed and comparable analyses on error severity.

Most medication error research however has been completed in small units and thus for comparative purposes that final data analyses may examine the impact of BCMA on specifically identified nursing units at CMMC. Differences between nursing units must be considered because of nurse-to-patient ratio, as well as hospital census differentials.

Work-arounds performed by nursing staff must be acknowledged as a contributing factor on the medication error rates. The following table demonstrates manual override statistics from CMMC for July through September 2013. Though these reporting statistics are not available during the study time period, researchers will utilize this data to make inferences to the impact on medication errors by clinical unit.

<b>McK Adoption HARx Analytics Medication Administration</b> <b>July - September, 2013 (3-month Average) N= 8,525 medications given</b>					
Schedule Override Count	% w Schedule Override	Drug Warning Override Count	% w Drug Warning Override	Quantity Override Count	% w Quantity Override
83	2.96	79	2.86	39	0.62

**Table 12. CMMC manual overrides by type (3-month average).**

Considerations for future research are to see if medication errors could be segregated based on origination (i.e if drug dispensed from the robot vs the MedCarousel vs. manual picks results in any differences in the number, type etc. of medication errors). No past studies investigated user compliance in the BCMA system (ie. work-arounds with the BCMA system). Such may need to be re-evaluated over time since as system familiarity evolves, so could the work-arounds. Longer-term follow-up studies (> 2 years) are needed both for the aforementioned reason and also for examination of the degree and time post implementation.

#### Nursing Time and Motion Final Results – CMMC & MYMC

The primary goal of the BCMA/eMAR implementation was to increase patient safety – hopefully not at the expense of procedural efficiency. A time and motion tool was employed to capture data capable of providing insight into changes of that efficiency for nursing (and pharmacy).

Study team personnel physically shadowed the clinician (RN or LPN) during multiple contiguous four-hour blocks of time during their work shift before (PRE) and after (POST) BCMA/eMAR implementation. Prior to shadowing, the study team met with the clinicians to confirm the completeness and accuracy of the activities listed on the time and motion tool, the activity (AID) index, as sufficient representations of the corresponding actual workday activities. Effort was made to obtain a representative data sample by varying the clinician, the hospital floor (e.g. patient type and load), and time of day of the observation. As used, the time and motion tool consisted of 35 unique activities (AIDs). The implementation of BCMA/eMAR was expected to alter nursing procedures particularly at the task (activity) level. Some tasks would be unaffected, some would be expanded in scope while others would be reduced, and a few would be eliminated. These procedural adjustments introduced variation from PRE to POST into some AIDs. The confounding influence of this variation was managed first through the defining of the AIDs so as to minimize the replacements from PRE to POST shadowing, and second by the categorization of the AIDs into work processes. The presumption being that the magnitude of any change at the AID level would not be so large as to change the process category of that activity. For analysis, each AID was placed into one of ten processes (PIDs); these processes represent collections of activities of related function, see Table 13. Nurse Shadowing: Process (PID) Details<sup>1</sup>.

Every time study personnel observed and recorded an activity, it represented an instance of that AID. When the observed task was not represented by a predefined AID, that instance was recorded using the 'other' AID. The time and motion tool recorded the elapsed time per each instance of an AID. The sum of the duration (time) of all the instances of AIDs yielded a total observation time per time period. Similarly, the sum of the time per instance of the AIDs assigned to a PID yielded the total time per PID. The total time of shadowing PRE and POST for each location was nearly equal (Table 13). A normalization procedure was therefore applied to allow for legitimate direct comparisons of the data between time periods (by location – CMMC and MYMC). The total time for each location by time period (PRE and POST) was calculated and used to normalize (rescale) the data. The

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<sup>1</sup> After further discussion, AID 19 was moved from PID 3 to 2; AID 20 from PID 3 to 11

elapsed time for each instance of AID was divided by the total time for each location. The normalized data was then multiplied by 100 to yield the outcome variable of analysis, dTime\_normd\_pct.

Total Time per Location and Time Period						
Time Period	MMC			MYMC		
	hh mm ss	seconds	Observations	hh mm ss	seconds	Observations
PRE	105:22:10	379,330	26	3:55:00	14,100	1
POST	104:53:31	377,611	26	4:15:58	15,358	1
difference between time periods	0:28:39			0:20:58		

**Table 13. Nurse Shadowing Total Time**

Note: seconds have been provided to ease the conversion of percentages and normalized data found in the text into units of time

This derived variable represents the percent of total time (per location per time period) for each instance of AID.

The between time period analysis, PRE vs. POST, for each location was applied on the following levels of stratification:

1. process (PID) and
  - a. BCMA/eMAR (and related) activities
2. individual activity (AID)
3. intra-location geography by PID

A PID is a stratification of the data by aggregating every instance of specific AIDs of related-function. Most PIDs contain multiple AIDs.

The BCMA/eMAR level of analysis focuses on a subset of AIDs of PID 1; specifically AIDs 4, 5, 14, and 24. This level of analysis was necessary since AIDs 4, 5, and 14 were directly impacted (replaced) by AID 24 (BCMA/eMAR, POST only). In fact, the data showed that AIDs 4, 5, and 14 were not used during the POST shadowing and therefore effectively eliminated. The tasks represented were now being accomplished by the BCMA/eMAR systems. Therefore, this analysis compared the aggregation of 4, 5, and 14 in the PRE with all instances of AID 24 (POST).

Activity ID (AID)	Process ID (PID)	Process Description	Individual Activity Description	Process ID
1	<b><u>1</u></b>	MED administration	Passing medications	1
2			Hang IV fluids	1
3			Retrieve meds from Pyxis, bins, or tube	1
4			Compare physical med to paper MAR	1
5			Confirm "Five Rights"	1
7			Passing IM/Subq meds	1
8			Passing transdermal meds	1
9			Stock or Retrieve from MED cart	1
14			Transcribe med orders - paper MAR	1
<b>24</b>			<b>eMAR</b>	1
11	<b><u>2</u></b>	computer charting	SCANning	2
19			review lab/rad results - computer	2
21			Admissions	2
22			Discharges	2
23			Standard	2
51	<b><u>3</u></b>	patient-related activities	Pt assessment-e.g. vitals	3
52			Physician Rounding-listening	3
53			Pt assistance-e.g. meals	3
64	<b><u>4</u></b>	talking in-person to::>	Colleague/Staff for Pt.	4
66			verbal report-out with nurses	4
71			Patient/Family	4
76	<b><u>5</u></b>	MED-related interruptions ONLY		5
73	<b><u>6</u></b>	waiting	waiting for MED cart	6
74			waiting for Pxyis access	6
72	<b><u>7</u></b>	walking inside		7
79	<b><u>8</u></b>	Phone	Patient (patient family)	8
80			Doctor	8
81			Nurse	8
82			Pharmacy	8
85			misc.	8
20	<b><u>9</u></b>	Paper	fax, copy	11
55			check or write PAPER charts	11
56			review lab/rad results - PAPER	11
70			Nurse's note for charting later	11
62	<b><u>10</u></b>	personal time-Any		10

**Table 14. Nurse Shadowing: Process (PID) Details .**

The AID analysis level is the aggregation of every instance of each AID used to create the PIDs. Intra-location geography is a stratification by unit within CMMC, namely:

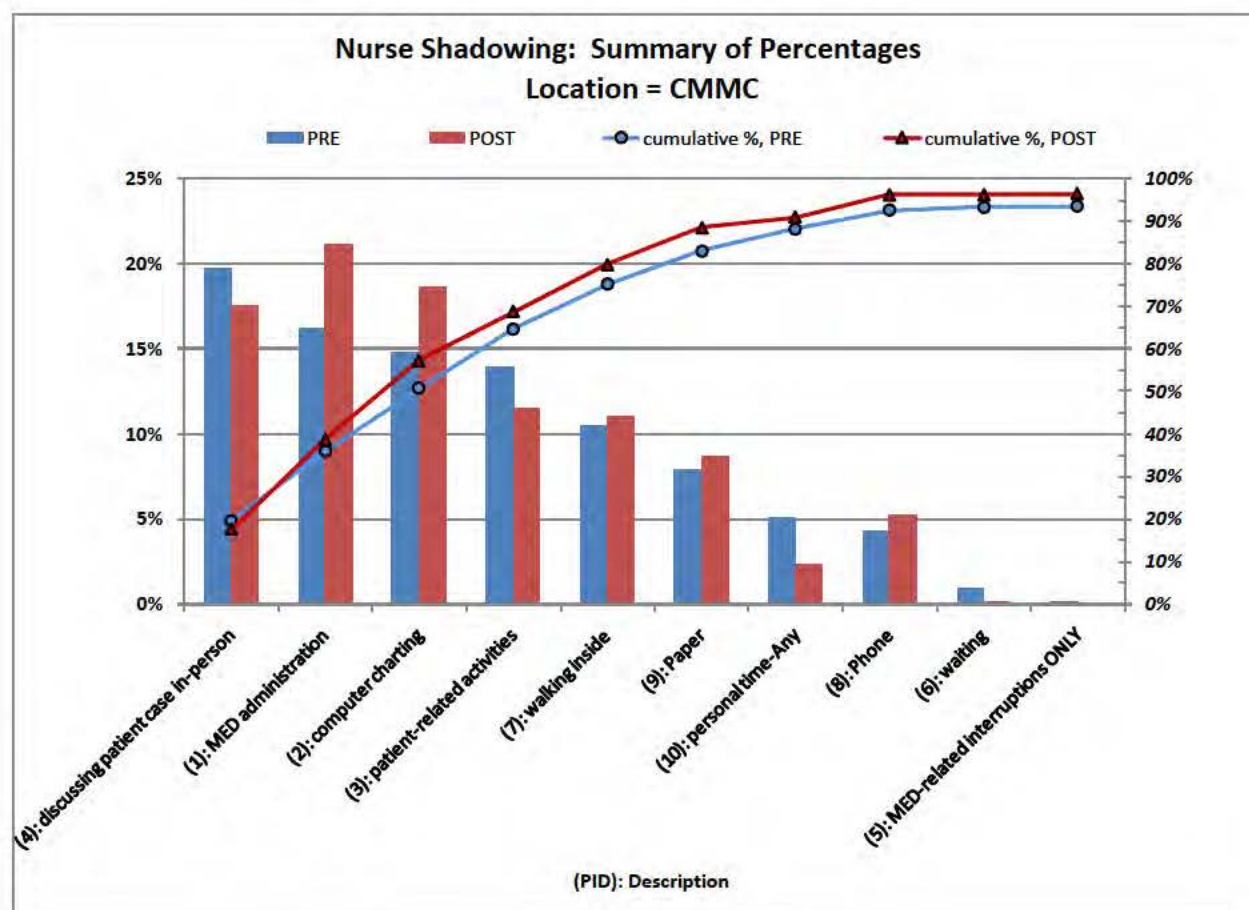
- A9 = Ashman/Rose Pavilion, floor 9, Ashman section
- R10 = Ashman/Rose Pavilion, floor 10, Rose section
- GS5 = Good Samaritan Building, floor 5
- MS7 = Medical Surgical 7

These floors were chosen as a representative sample of CMMC based upon physical layout and patient composition. Given the size of MYMC (20-bed rural hospital), the intra-location geography concept is not applicable.

ANOVA analyses, between time period (PRE vs. POST), was accomplished for each location (CMMC and MYMC) separately. Applying an ANOVA analysis to dTime\_normd\_pct provides the

most effective manner in which to simultaneously account for both intrinsic characteristics of this dataset, sum of time and frequency, that influence the quantification of efficiency (productivity) and gross system changes. Analysis of the mean of dTime\_normd\_pct accounts for both components and provides directly comparable results across time periods. A family-wise alpha = 0.05 was set as the criteria for statistical significance.

The statistically significant finding on the BCMA/eMAR level implies that the implementation is being utilized as intended. Also, since no PID individually and only one AID individually, which likely would not be influenced by BCMA implementation, showed statistical significance, the results imply that the implementation of bar coded medication administration did not positively or negatively impact the efficiency of the nursing workflow at CMMC as analyzed. Please refer to Figure 11 and Tables 19 and 20 (Appendix 4) for details.



**Figure 11. Nurse Shadowing: Summary of Percentages, CMMC**

Note: Cumulative percent does not reach 100% because the "Other" PID is not graphed since these activities are not germane to the analyses.

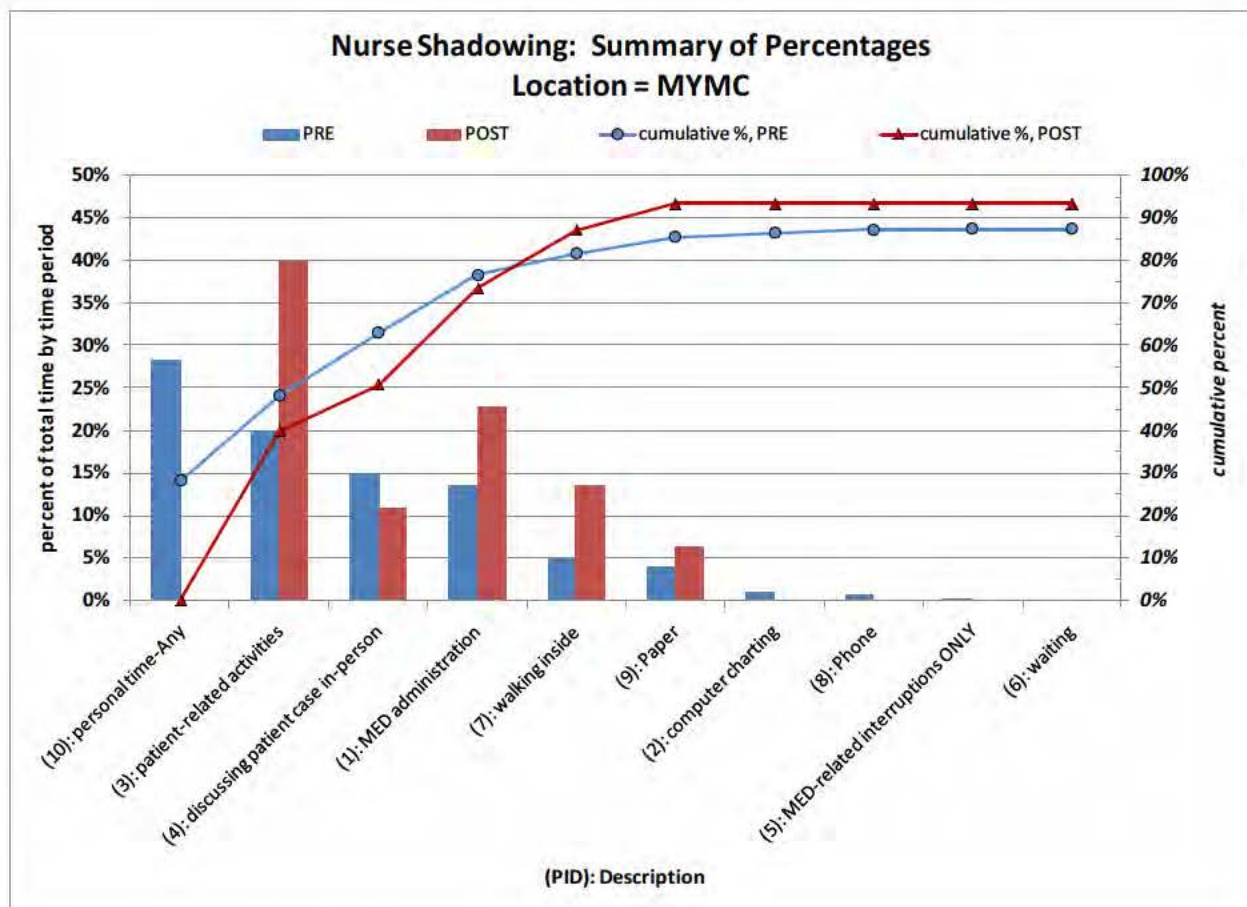
PRE vs POST			PID	n <sub>PRE</sub>	n <sub>POST</sub>	p-value	Change of the mean <sub>POST</sub> relative to that of the PRE
PIDs, individually			No statistical significance was found.				
BCMA/eMAR			1 (subset of)	432	681	< 0.0005	Increase
Intra- location geography	by PID	A9	1	475	512	0.013	Increase
			2	124	182	0.005	Decrease
		GS5	No statistical significance was found.				
		MS7	4	269	264	0.045	Decrease
			7	229	284	0.027	Decrease
		R10	1	270	342	0.009	Increase
AIDs, individually		AID 3	1	238	179	< 0.0005	Decrease

**Table 15. Summary of Statistical Findings - CMMC**

Also, for CMMC, analyses were conducted on average daily census (ADC), case mix index (CMI) and between intra-location geography. PRE was compared with POST. Given the sample size for the PRE time period, Mann-Whitney test was used. No statistical significance was found overall for the analysis by time period. The data set was stratified by intra-location geography and repeated. No statistical significance was found. The between intra-location geography ANOVA produced a significant contrast only between A9 and GS5 (p-value = 0.029) indicating that these two floors differ from each other on dTime\_normd\_pct. No evidence was found to imply that this result impacted the conclusions drawn overall.

#### MYMC:

Statistical significance was found for two groupings, 'MED administration' and 'Talking in-person', but no individual activities. Statistical significance was found for BCMA/eMAR level as well, implying that the implementation is being successfully utilized as intended. The findings must be viewed with caution since the data contains observations from only one clinician for one four-hour time period, which is insufficient to be a representative sample; an unavoidable consequence of the typically low patient census at this location. If the significance would hold for a more representative sample, the implication could be that BCMA has some influence at MYMC. Please refer to Figure 12 and Tables 21 and 22 (Appendix 4) for details.



**Figure 12. Nurse Shadowing: Summary of Percentages, MYMC**

Note: Cumulative percent does not reach 100% because the "Other" PID is not graphed since these activities are not germane to the analyses.

<i><b>PRE vs POST</b></i>	PID	$n_{PRE}$	$n_{POST}$	p-value	Change of the mean $n_{POST}$ relative to that of the PRE
PIDs, individually	1	35	22	0.001	Increase
	4	16	28	0.03	Decrease
BCMA/eMAR	1 (subset of)	24	12	< 0.0005	Increase
Intra-location geography	Not Applicable				
AIDs, individually	No statistical significance was found.				

**Table 16. Summary of Statistical Findings - MYMC**

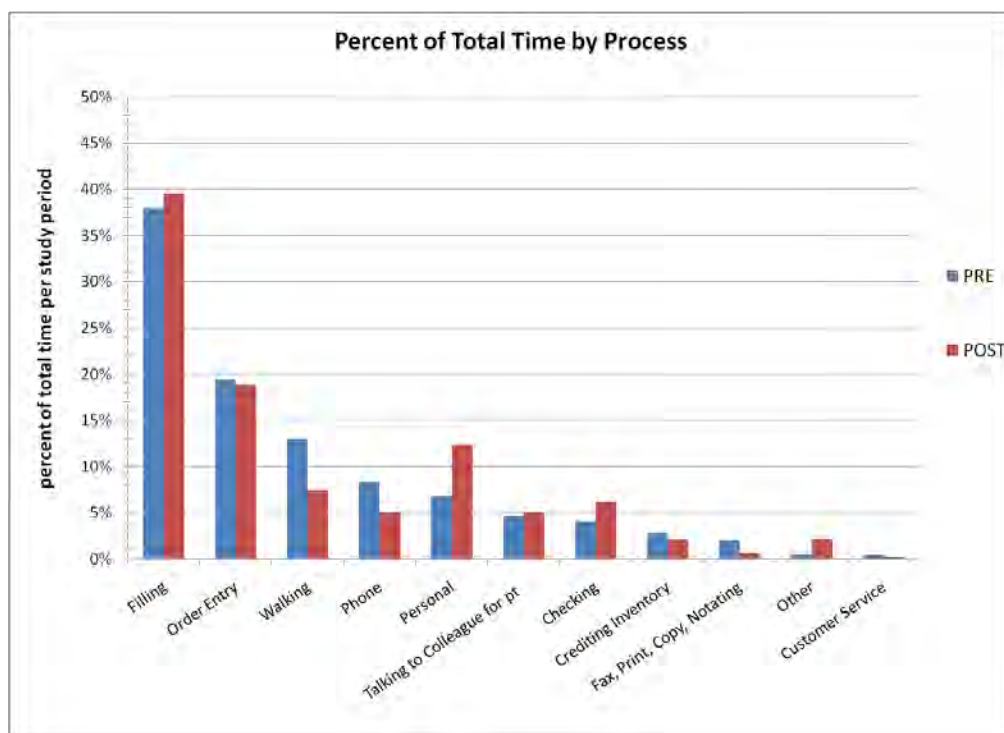
### Pharmacy Time and Motion Study - CMMC

The research team completed time and motion observations of pharmacists and technicians starting the week of April 22<sup>nd</sup>. This data collection occurred after the implementation of the second MedCarousel. A total of 12 observations were performed to match baseline data collection, including the same day(s)/time(s) of the week and similar time of year (seasonality). Each subject was shadowed for a 4-hour period as detailed in the table below.

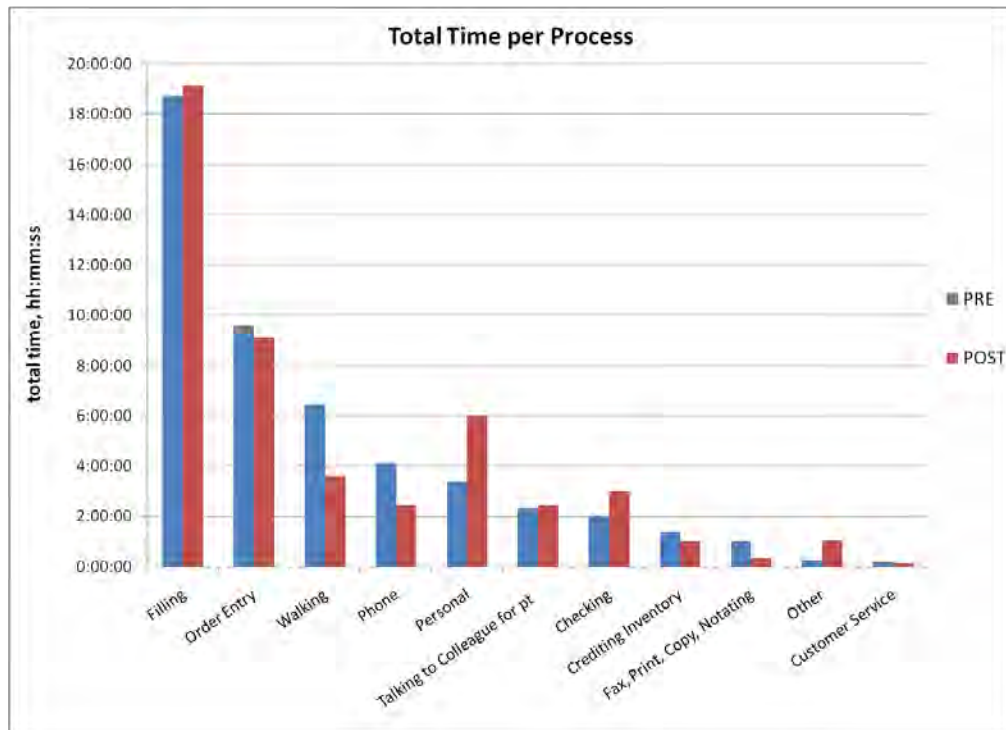
Date	Time	Position
April 22, 2013	7:00 - 11:00 AM	Pharmacist
April 23, 2013	9:00 PM - 1:00 AM	Pharmacist
April 24, 2013	8:30 AM - 12:30 PM	Technician
April 29, 2013	12:00 - 4:00 PM	Pharmacist
April 30, 2013	9:00 PM - 1:00 AM	Technician
May 2, 2013	2:30 - 6:30 PM	Pharmacist
May 8, 2013	10:00 AM - 2:00 PM	Technician
May 13, 2013	11:00 AM - 3:00 PM	Technician
May 15, 2013	3:00 - 7:00 PM	Technician
May 17, 2013	8:30 AM-12:30 PM	Technician
May 20, 2013	7:00-11:00 AM	Technician
May 24, 2013	7:00-11:00 AM	Technician

**Table 17. Pharmacy Time & Motion Schedule.**

The following chart displays descriptive results per process grouping.



**Figure 13. Percent of Total Time by Process (PRE VS. POST).**



**Figure 14. Total Time per Process (PRE VS. POST).**

The infusion of bar code technology into the pharmacy at CMMC had significant impact on staff, processes, and the overall atmosphere of the department. Upon preliminary examination of the data collected in 2011 (PRE) compared with data collected in 2013 (POST), multiple workflow process alterations have been noted. Information regarding patient census, staffing levels, process changes, etc will be considered for the final study report.

An expected benefit of automation is the consolidation of inventory in known locations to staff. Pharmacy technicians spent nearly the same amount of time filling medication orders between the PRE and POST time periods. This can be considered a positive result of the new technology, as the automation of processes did not increase the time for drug dispensation. However, efficiency gains were not quantitatively realized for this process. (Discussion as to the possible reasons for this result will be examined during the more in-depth data analyses.) The results do show a decrease in the amount of time spent crediting inventory; likely due to the automation process now employed to complete this task and/or the distribution of the prescribed quantity and type of drug(s) dispensed to the floor.

A reduction in phone calls and in handling paper (Fax, Print, Copy, Notating) has been shown during the POST period. This implies fewer calls from the floor (e.g. nurse) were received questioning the status of ordered medications as well as less hand-off communications (i.e. paper handling). A reduction in physical walking has also been realized, implying technicians are spending less time traversing to fill medication orders and is also demonstrative of the overarching role of the robotic technology – to fill patient prescription orders via automation.

The increase in personal time (e.g. meal break) during the POST assessment can be seen as a positive outcome from the perspective of employee satisfaction and perhaps increased task completion efficiency, as pharmacists and technicians are seemingly able to more consistently take scheduled breaks during shifts.

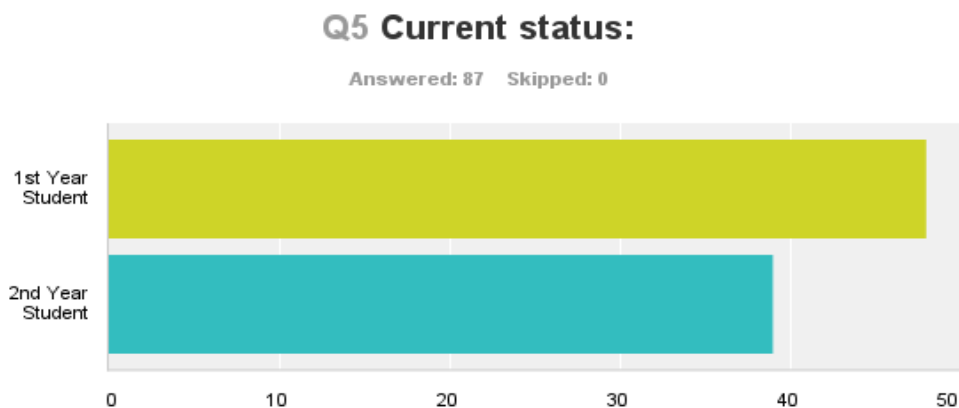
Initial examination of the data also revealed the following:

- A small decrease in time spent for order entry. This is expected because this process was not primarily impacted by technology upgrades or automation. Computerized physician order entry (CPOE), currently being piloted by a small group of CMMC physicians (not included in MIDHT scope) was anticipated to increase efficiencies, but was rarely observed during workflow shadowing.
- A small increase in time spent checking medications. This result is surprising because procedurally only 10% of medications dispensed from the robot are checked by a pharmacist (POST) whereas 100% of all medications manually filled by technicians were reviewed in the PRE period.

#### School of Nursing Bar Code Medication Administration (BCMA) Survey

An abbreviated BCMA baseline survey was distributed to all nursing students on December 3, 2012. A strong response was received (n=102) before the survey was closed on December 14, 2012. Survey respondents that followed instructions received a token incentive for completing a valid survey. Five respondents stated in written comments that they would like improved access to medication carts for training purposes.

A total of 87 Conemaugh nursing students completed the POST BCMA survey during April and May of 2013, which included a good balance between 1<sup>st</sup> and 2<sup>nd</sup> year students. The following select questions suggest a positive change in access to the system after additional medication carts were made available and a favorable opinion of the BCMA system on improving patient safety.



**Figure 15. Current status of nursing student.**



**Figure 16. Access to medication carts – POST.**

Comparison of mean statistics between PRE (Sometimes – 2.75) and POST (Very Often – 3.21) results suggest a positive change occurred through the purchase of additional medication carts for the School of Nursing. Ultimately, a favorable training experience was created through improved access to the BCMA system.

**Q10 The current medication administration system is effective in reducing and preventing medication errors.**

Answered: 81 Skipped: 0

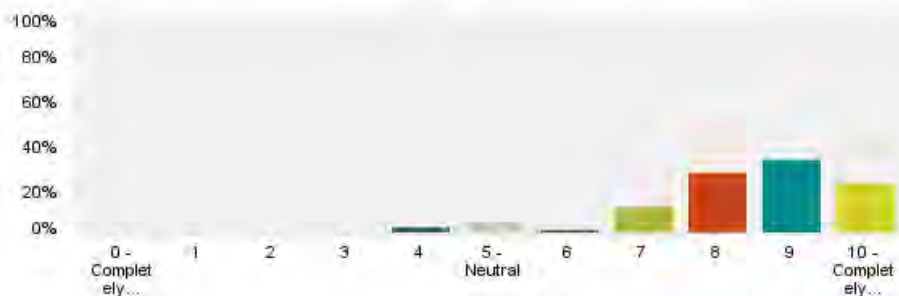


**Figure 17. Impact on preventing medication errors.**

Nursing students did not suggest any real change in patient safety deduced from the same median and mode for both time periods (Strongly Agree). Overall, they believe the BCMA system is effective in preventing medication errors but additional system usage did not change their opinion.

**Q11 Overall, how satisfied are you with the current medication administration system?**

Answered: 81 Skipped: 0



**Figure 18. Overall satisfaction of BCMA system.**

Overall satisfaction did not change over time with a median of 9.0 for both PRE and POST data sets. Nursing students have a favorable opinion of the BCMA system and likely cannot compare historically to the manual medication administration system previously used at Conemaugh.

## Arm 2: Health Information Exchange (HIE) via the Nationwide Health Information Network (NwHIN)

Subtask 2.1 Deploy a limited production, NHIN standards-based HIE focusing on the bi-directional exchange of electronic medical records between CHS and the Military Health System. CHS information to include data domains residing in acute care and ambulatory settings.

### Conemaugh Activities

The initial Virtual Lifetime Electronic Record (VLER) mass mailing was sent to 355 veterans on October 1<sup>st</sup> and 2<sup>nd</sup>. For the first quarter, 42% of patients decided to participate in the program. The mailing included a joint letter (see Appendix 5), two consent forms and marketing materials. Conemaugh handled all administration aspects of the mailing.

Once a Veteran returns completed consent forms, MIDHT staff “opt-in” that specific patient through the CONNECT Consumer Preferences Profile (CPP). VA forms are provided to them on a weekly basis as needed. Patient correlations are checked frequently to determine status of linkages.

Once a correlation is made between Conemaugh and the VA, MIDHT staff adds chart alert within the Allscripts electronic health record to notify providers of the event. This process was implemented in mid-November.

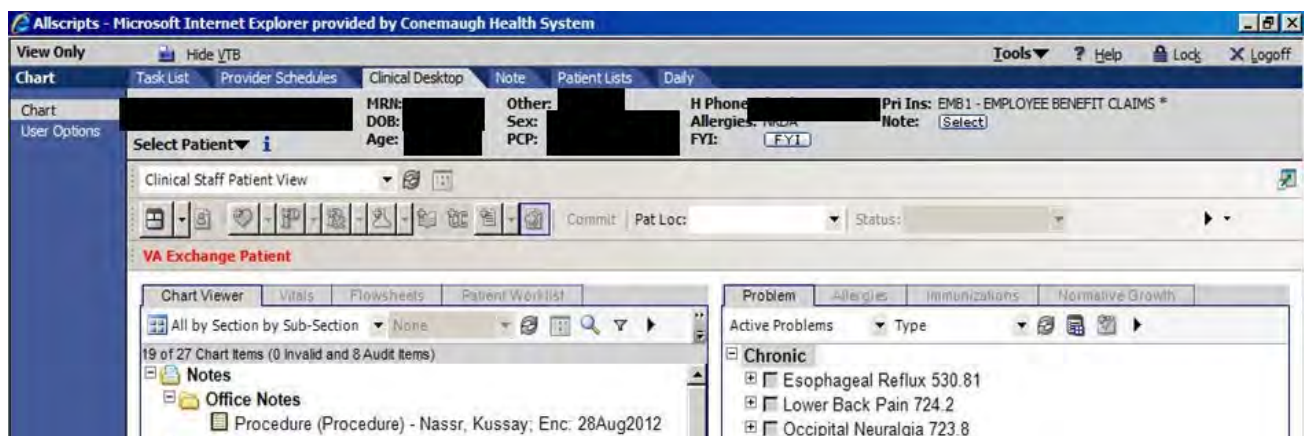


Figure 19. Allscripts Chart Alert.

Conemaugh staff completed refresher training with Portage Health Center on October 31, 2012 and Ebandjeff Health Center on November 14, 2012. New system users are added to the OpenDS directory service as needed and MIDHT staff also adds them to the “NwHIN Users Group” on a regular basis so they can access the CONNECT application via Care Portal.

An initial meeting was held with Dr. Lieb and St. Benedict staff on December 11, 2012, in which the VA Exchange project was detailed. The meeting went well and they were excited to participate. Invitations to known shared patients (n=62) were mailed on December 26, 2012.

Conemaugh staff assisted Northrop Grumman Corporation (NGC) during the month of December with the MIDHT server move to Chester, VA, including MPI, CAL, VPN and Care Portal configuration changes. Conemaugh worked with HealthWay to update the UDDI registry with new GO-LIVE endpoints. The Conemaugh gateway had a downtime of 1.5 business days.

Conemaugh participated in VA testing activities on December 5, 2012. VA completed an adapter upgrade and we confirmed that the service was operational and that numerous C32 changes were reflected through xml examination.

Project team identified an issue where medication data (from Allscripts) for some patients was not being populated in the CAL response and therefore the C32 clinical document. Issue was resolved on March 27, 2013 and verified accurate through testing.

Conemaugh has been working with Sunquest Information Systems, Inc. to discuss an on-demand HL7 v2 interface for hospital-based lab results. A quote was prepared for client review. The addition of lab results to the Conemaugh C32 has been requested by Altoona VAMC stakeholders and will support coordination of care and quality initiatives. Conemaugh had been working with Sunquest Information Systems, Inc. to stand up an on-demand HL7 v2 interface for hospital-based lab results. A purchase order was executed on April 24th and sent to the vendor. Conemaugh has been frustrated by the lack of movement by Sunquest on this project. A project schedule was finally provided to CMMC on August 7, 2013, based upon availability of Sunquest resources. The project was expected to begin in early September but has been further delayed by the vendor.

Response by Veterans to the VLER mailing invitations continues to be strong. Table 18 summarizes various efforts during the quarter to increase the number of authorizations (i.e. patients opted in), including patients of CPG St. Benedict and a "Final Notice" mailing to patients (occurred in mid-February) of the initial pilot group. John Hargreaves met with four Conemaugh primary care practices during the month of March to discuss the purpose of VLER and HIE. System training was also completed with staff, showing them how to request documents from the VA. New CONNECT accounts were created in conjunction with user setup. We also have approached "shared patients" that do not have a primary care provider (PCP), patients with VA PCP's and patients with an independent PCP.

Item	# of veterans contacted	# of veterans that responded	# of veterans correlated
CPG St. Benedict	63	40 (63%)	39
CPG East Hills	74	43 (58%)	43
CPG Portage	140	46 (33%)	46
CPG Ebandjeff/Park Hill	119	53 (45%)	53
CPG Berkley Hills	55	35 (64%)	35
No PCP	463	101 (22%)	99
CPG Highlands	49	19 (39%)	18
CPG Dr. Pote	23	12 (52%)	12
CPG Dr. Gvozden	50	15 (30%)	14
CPG Drs. Massoud and Sirsikir	72	22 (31%)	22
CPG Dr. Johns	67	19 (28%)	18
VA Providers	58	14 (24%)	14
Dr. Munzer	32	13 (41%)	12
Dr. Trostle	18	4 (22%)	4
Other Independent Practices†	400	31 (8%)	4
Face to face	43	43 (100%)	43
TOTAL DURING YEAR	1,726	510 (28%)	476
<b>GRAND TOTAL</b>	<b>1,743</b>	<b>526</b>	<b>492</b>

† Invitations sent in September 2013

**Table 18. Patient Authorizations and Correlations.**

The difference in the number of veterans that responded and are correlated is not due to patient discovery failures but rather issues with VLER authorizations (e.g. not signed/dated, not completed) and the time delay for both organizations to “Opt-In” patients into their system. A small percentage of invitations have been “returned to sender” for various reasons, including those regarding deceased patients and address changes.

John Hargreaves, Project Manager, met with three physician practices to discuss VLER and health information exchange, including two independent practices (Dr. Trostle/Dr. Zeidan). Dr. Zeidan is a specialist and does not have shared patients identified in the list.

### **eHealth Exchange Participant Testing**

In order to be fully compliant with eHealth Exchange requirements after implementing a CONNECT 3.3.1.3 gateway, Conemaugh participated in the new eHealth Exchange testing program. After working six weeks with the testing body (The Certification Commission for Health Information Technology®) and support contractor for the Developers Integration Lab (Aegis), Conemaugh was the first participant in the nation to pass the 2010 Smoke Test Cases, 2011 Smoke Test Cases, and 2011 Security Test Cases on September 4, 2013 (see Appendix 6). Conemaugh was also the first VLER partner to complete the transition to 2011 services.

## **CAL and Document Assembler Code Donation**

In partnership with NGC, Conemaugh completed a code donation to the FHA/CONNECT team on October 11, 2012 and November 20, 2012. The second donation was requested in order to reduce the number of CheckStyle and PMD violations in order for the build to complete successfully. As of the end of the period, the CONNECT team has not integrated the Conemaugh code donations into the source code tree. Despite this delay, the binary files and instructions were made available to the community on October 18, 2012, at the following url:

<https://developer.connectopensource.org/display/CONNECTR33/Dynamic+Document+Generation>

The code donations were also reviewed by John Hargreaves and Allen Barger during the CONNECT Code-A-Thon on November 7-8, 2012.

## **Subcontractor Transition**

Conemaugh's subcontract with Northrop Grumman will expire on September 30, 2013. Conemaugh has competitively selected CGI Federal, Inc. as the new vendor to support Conemaugh's eHealth Exchange production environment on an as needed basis. We also received proposals from Northrop Grumman, Cogon Systems and MEDfx. The time and material agreement is being drafted and should be executed the first week of October.

Before Northrop Grumman's contract expired, MIDHT equipment was moved to the hospital data center in Johnstown, PA on September 23, 2013. A minimal two-day downtime occurred while the servers were put into operation in the new location with appropriate networking gear and Internet service. Follow-up testing was completed to ensure the production UDDI change was successful.

## **Allscripts Clinical Analytics**

The Allscripts Clinical Analytics application was remotely demonstrated for MIDHT team, CPG, and MIS staff on September 23, 2013. All MIDHT-related questions raised were addressed during the demonstration or via follow-up email communications from Allscripts. Current plan is to contract in October and install in early February 2014 as soon as Allscripts v11.4.1 upgrade is operational.

## Northrop Grumman Subcontractor Support

The following activities are selected highlights completed by Northrop Grumman during the year.

### **Cycle 4 development:**

- Increased the *max\_allowed\_packet* size in MySQL to allow for large BLOBs to be saved to the audit repository table.
- Modified the VA style sheet so that the date values in the Lab Results section are formatted and the header of each C32 section contains information about the patient (name, date of birth).
- Moved the location of the Lab Results comments in the VA style sheet from the last column in the Lab Results table to a new row that directly follows the current entry in order to reduce document size.
- Added functionality to the VA style sheet that allows the user to dynamically change the font size of the C32 content.
- Monitored patient correlations and communicated updates to Conemaugh
- Generated bi-weekly audit logs and delivered to Conemaugh
- Appended “(INCLUDES LAB RESULTS)” to the end of the “34133-9 Summarization of Episode Note” entry in the CONNECT Universal Client GUI’s *Select Document Types* drop-down box.
- Determined that a display issue with the Problem date values was the result of the XML that is returned from the VA.
- On January 17, 2013, the new ENTRUST Certificate (valid for one year) was successfully installed
- Hid the CONNECT Universal Client GUI’s service time query components (VA currently experiencing an issue with proper handling) and added the Document Query response’s *serviceStartTime* value to the Document Query results table
- No longer populating the CHS C32 Allergy Event Type with the CAL response value. Instead, set the Allergy Event Type to the valid Snomed Code value of “Propensity to adverse reactions (disorder)”
- Inspected the Sig, Order Expiration, Provider, and Dispense Date fields in the Medications section of the CHS C32 for missing values
- Determined the CAL Medications response does not contain pharmacy information
- Made the following changes in production to the Medications section of the Conemaugh C32 document per request from VA:
  - Populated the *substanceAdministration* text tags with only the medication Sig value
  - Put the section text *<content>* tags in the same order as the corresponding *SubstanceAdministration* entries

- Changed the ID attribute of each section <content> tag to be the medication Sig value instead of the name of the medication
- Always display “N/A” for service time in the Document Search Results table for C32 documents that are returned to the CONNECT Universal Client GUI
- Corrected the spelling of what’s supposed to be the word “Document” in the first column of the Document Search Results table.
- Created user accounts in OpenDS and updated passwords as requested.
- When requested, queried the MIDHT Audit Repository to confirm the Retrieve Document actions of certain VA users.
- In response to the Healthway eHealth Exchange support staff assuming administrative control for the UDDI domain registrar services, connectivity from the production Conemaugh gateway to the production eHealth Exchange UDDI was tested on July 8, 2013.
- Prevented the CONNECT Universal Client GUI’s Logout button and User’s Manual link from disappearing when a user selected a date from the Patient Search tab’s calendar control.
- Provided Conemaugh documentation regarding how to efficiently create audit log files and the correlations tables in Excel format.
- Provided Conemaugh a list of all the “projects” that have been changed or added to support Lab Results.
- Provided Conemaugh with documentation regarding how new MIDHT users are added to OpenDS.
- Provided Conemaugh with instructions on how to determine which Conemaugh documents are provided to the VA.
- Helped Conemaugh troubleshoot an issue with their updated UDDI registry entries.

#### **TATRC Partners and Open Source Community Outreach**

- NGC became a regular participant in the eHealth Exchange Spec Factory all-hands weekly teleconference.
- NGC continued to participate in the bi-weekly CONNECT Sprint Review and Planning Session meetings.
- COGON Systems reached out to Allen Barger for help with validating the C62 document that they had been sending to the VA. Allen helped COGON validate their C62 document by performing the following actions:
  - Compared the COGON C62 document to a valid Conemaugh C62 document and suggested revisions

- Loaded the COGON C62 document into the CAL emulator, and then rendered it using the CONNECT Universal Client GUI.
- On July 1, 2013, Allen Barger met with staff members from Regenstrief and provided them with guidance and lessons learned regarding C62 document development.
- On July 22, 2013, Allen Barger participated in the Healthway Testing Program Update.
- On July 25, 2013, Allen Barger dialed-in to the Healthway Testing Brief.
- At the suggestion of Conemaugh, Allen Barger reached out to members of FHA to discuss the default Availability Status value in CONNECT.

### **Transition to CONNECT v3.3.1.3**

- Created and distributed a transition plan that documents the tasks that are required to move the MIDHT code base from CONNECT v3.1 to CONNECT v3.3.x.
- Created a Subversion trunk to hold version documentation that is pertinent to the installation & configuration of the MIDHT code on CONNECT v3.3.1.3.
- Evaluated versions of OpenDS that are suitable for deployment with the Java install that is required by CONNECT v3.3.1.3.
- Updated the MIDHT code base to work with the CONNECT v.3.3.1.3 Core Libraries.
- Provided TATRC the CONNECTUniversalClientGUI binaries for use with CONNECT v3.3.1.3
- Created and deployed a common Java library for the CONNECT Universal Client GUI and the Consumer Preferences Profile GUI. The library eliminates the need to have the same files stored in both the CONNECT Universal Client GUI and Consumer Preferences Profile web applications.
- Created and deployed an updated Initiate adapter for use with CONNECT v3.3. The updated adapter eliminates an extra web service call and facilitates the use of the CONNECT build script to compile the adapter's code.
- Updated the AdapterCommonDataLayerEJB, AdapterDocumentAssemblyProxyEJB, DocumentAssemblyManagerEJB, DocumentManagerEJB, NHINAdapterServicesEJB, and TemplateManagerEJB projects to accommodate the CONNECTCoreLib changes in CONNECT v3.3.1.3.
- Resolved the CONNECT Universal Client GUI issue that caused patient id's to be persisted across GUI sessions and included in the SAML header of future transactions.
- Sample C32 and C62 documents were produced from the transitioned MIDHT code and sent to Conemaugh for review.

- The CONNECT v3.3.1.3 Entity Doc Query, Adapter Doc Query, and NwHIN Doc Query requests and responses were compared to their CONNECT v3.1 counterparts.
- The CONNECT v3.3.1.3 C32 and C62 documents were compared to their CONNECT v3.1 counterparts.
- The CONNECT v3.3.1.3 document repository, audit repository, and patient correlation tables were compared to their CONNECT v3.1 counterparts.
- Work began on transitioning the CONNECT v3.3.1.3 code from Allen Barger’s development machine to the MIDHT-PREPROD33 server.
- A CONNECT bug may be responsible for wrongly populating the Issuer and Issuer Format SAML Assertion values in the Audit Log and Adapter Document Query web service requests.
- Work was completed on creating a document that outlines how to install and configure the MIDHT code stack, built from CONNECT v3.3.1.3, on a Windows-based server.
- The following changes were made to the MIDHT CONNECT v3.3.1.3 code base:
  - Properly formatted the Date of Birth (DOB) and telephone number values in the Patient Discovery request
  - Added an “XDSDocumentEntryType” slot, used to request both stable and on-demand documents from eHealth Exchange participants, to the Document Query request
  - Changed the value of the “returnComposedObjects” attribute, located in the Document Query request, from “false” to “true”
  - Changed the Issuer SAML header value to be compliant with the NwHIN Authorization Framework and Oasis SAML specifications.
- Delivered a document to Conemaugh that outlines how to install and configure the MIDHT code stack, built from CONNECT v3.3.1.3, on a Windows-based server.
- The following changes were made to the MIDHT CONNECT v3.3.1.3 code base:
  - Set the Initiate min score to 99 for both internal and external patient lookups
  - Prevented the CONNECT Universal Client GUI from caching the internal Initiate min score after a patient lookup is performed in the GUI
  - For every MIDHT document that is saved to the document repository, populate the document’s AvailabilityStatus repository field with “Available” instead of “Active”
  - For DQ requests that originate from the CONNECT Universal Client GUI, include a \$XDSDocumentEntryType slot in the request if the targeted community supports the 2011 eHealth Exchange specifications.

- To more easily identify incoming 2010 DR requests, the print-lines in the v2.0 Document Retrieve Implementation class were appended with a 2010 designation
  - Enabled complete builds of the CONNECT code stack by updating the AdapterFrameworkIntTest project to work with architectural changes that were made to the Dynamic Document Assembler code
  - Increased the Document Query web service Proxy timeout threshold.
- The migration of the CONNECT v3.3.1.3 MIDHT code base from the MIDHT-PREPROD33 server to the MIDHT-GOLIVE server was completed on September 19, 2013.

### **MIDHT Data Center Configuration and Maintenance**

- Conemaugh granted permission to NGC to relocate the MIDHT equipment to a data center located in Chester, VA. The NGC facility in Johnstown, PA permanently closed on December 17, 2012.
- Essential MIDHT equipment was relocated to the Chester, VA datacenter during the weekend of December 14, 2012.

### **VA Partner and eHealth Exchange Testing**

- On November 13, 2012, VA test cases were executed to monitor C32 changes that were made in support of VA's Adapter Maintenance Release 5.0.1. During the testing process, several Conemaugh initiated Patient Discovery, Document Query and Document Retrieve requests were sent to the VA test system and the returned responses were examined for accuracy.
- Northrop Grumman examined the VA C32 module content, which was produced during Adapter 5.0.1 validation testing, for accuracy and reported the findings to Conemaugh.
- The DIL certificates were successfully retrieved from Aegis and installed on the MIDHT-PREPROD33 server.
- On July 31, 2013, Allen Barger attended the eHealth Exchange Participant Testing Webinar.
- The uddiConnectionInfo\_CONNECT33\_41.xml file, which is used to direct the CHS gateway to the DIL endpoints, was successfully installed on the MIDHT-PREPROD33 server.
- On July 25, 2013, Allen Barger met with John Hargreaves to review the CONNECT testing documentation and the DIL setup and administration instructions.
- At the request of the VA, Document Query tests were conducted for test patient NWHINONE on July 8, 15, and 17, 2013. The test results were extracted from Conemaugh's server log and sent to the VA for review.

- Helped determine if a `NullPointerException`, which prevented the DIL from sending requests to the Conemaugh test gateway, was originating from the DIL or Conemaugh's gateway.
- On August 1, 2013, Allen Barger attended a Conemaugh Test Gateway Kick-off meeting, which was organized by the VA.
- During a teleconference on August 13, 2013, Allen Barger discussed eHealth Exchange testing document metadata values with John Hargreaves from Conemaugh and Heather Geier from CCHIT.
- Northrop Grumman helped Conemaugh interpret a DIL error message regarding a missing patient id, and determined that a non-breaking space appended to the end of the patient id was the cause of the error.
- After eHealth Exchange validation testing concluded, the certificates, domain.xml file, and uddiConnectionInfo.xml file on the MIDHT-PREPROD33 server were configured for validation testing with the VA.
- On September 11-12, 2013, Allen Barger participated in the validation testing sessions that took place between Conemaugh and the VA.

### **CONNECT Code-a-Thon Participation**

- Allen Barger attended the CONNECT Code-a-Thon, held at Marymount University on November 7-8, 2012, in support of the MIDHT project.
- Allen Barger actively participated in discussions regarding the CONNECT code donation process and the Dynamic Document Generation plug-in code donated by Conemaugh.

### **Lab Result Integration**

- On February 13, 2013, Allen Barger and Emily Reynolds attended a meeting with Conemaugh to discuss the addition of Lab Results to the MIDHT C32 document.
- Using sample messages provided by Conemaugh, NG successfully parsed HL7 v2.2 Lab Result messages using the open-source HL7 Application Programming Interface (HAPI) library to HLV v3.
- Assisted Conemaugh with identifying the data objects that comprise a HL7 v2.2 message.
- Coding efforts have produced a C32 document containing a Lab Results section that is populated with static Laboratory Observation data. As changes are made to the Lab Results section of the C32 document, the document's adherence to the CDA/CCD-based specifications are routinely validated using the NIST testing web site.
- In order to determine if the Lab Results Integration code needed to be modified to handle multiple Lab Orders and Results messages, the Northrop Grumman MIDHT team

requested additional sample Lab messages from Conemaugh. The sample messages were received by the Northrop Grumman MIDHT team on April 8, 2013.

- In anticipation of the Conemaugh Labs interface requiring HL7 ORM message based requests, Northrop Grumman and Conemaugh researched the content and structure of the ORM message type. However, it has since been determined that the Conemaugh interface will require ORU message based requests.
- The Document Assembler code was successfully modified to accommodate the parsing and interpretation of messages containing multiple Lab Orders and multiple Lab Results (for a given Lab Order).
- The CHS style sheet was augmented with a Lab Results section, which contains a Date/Time field, a Result Type field, a Result Value field, a Reference Range field, an Interpretation field, a Result Status field, and a Source field. A revised CHS C32 document containing Lab Results was delivered to Conemaugh on April 3, 2013 for review.
- Code was implemented to allow the represented organization for each Lab result to dynamically change based on the hospital code value in the MSH section of the ORU\_R01 message.

#### **Subtask 2.2 Provide technical and documentation assistance on DoD-managed Virtual Lifetime Electronic Record (VLER) efforts.**

\*\*\*\*\*No specific tasking has been identified by TATRC\*\*\*\*\*

#### **Subtask 2.3 Investigate productizing a Patient Consent module using established standards, such as TP20/XACML.**

Conemaugh and NGC agreed to participate in the Jericho/UT-Austin DS4P Pilot in July 2012 by serving as a test CONNECT gateway on a simulated eHealth Exchange. Due to contracts and funding issues with others, the pilot began work in April 2013. More information can be found here about the pilot: <http://wiki.siframework.org/Data+Segmentation+for+Privacy+Homepage>

This pilot explores 12 electronic exchange scenarios and eight types of data transactions. To test these scenarios, pilot participants perform various roles. Jericho Systems serves as primary custodian of the patient's record and houses the Patient Consent Directive (PCD) repository. The University of Texas at Austin HIT Program simulates the role of a research university that requests the patient's record and subsequently acts as the secondary custodian of the information. Conemaugh plays the role of a marketing network that becomes the second requestor.

In support of the DS4P J-UT pilot, a CentOS Virtual Machine (VM) image was successfully retrieved from Jericho and installed on a MIDHT test sever in August 2013. Once installed, the GlassFish server contained within the VM was configured to use ports 443 and 80 instead of ports 8181 and 8080.

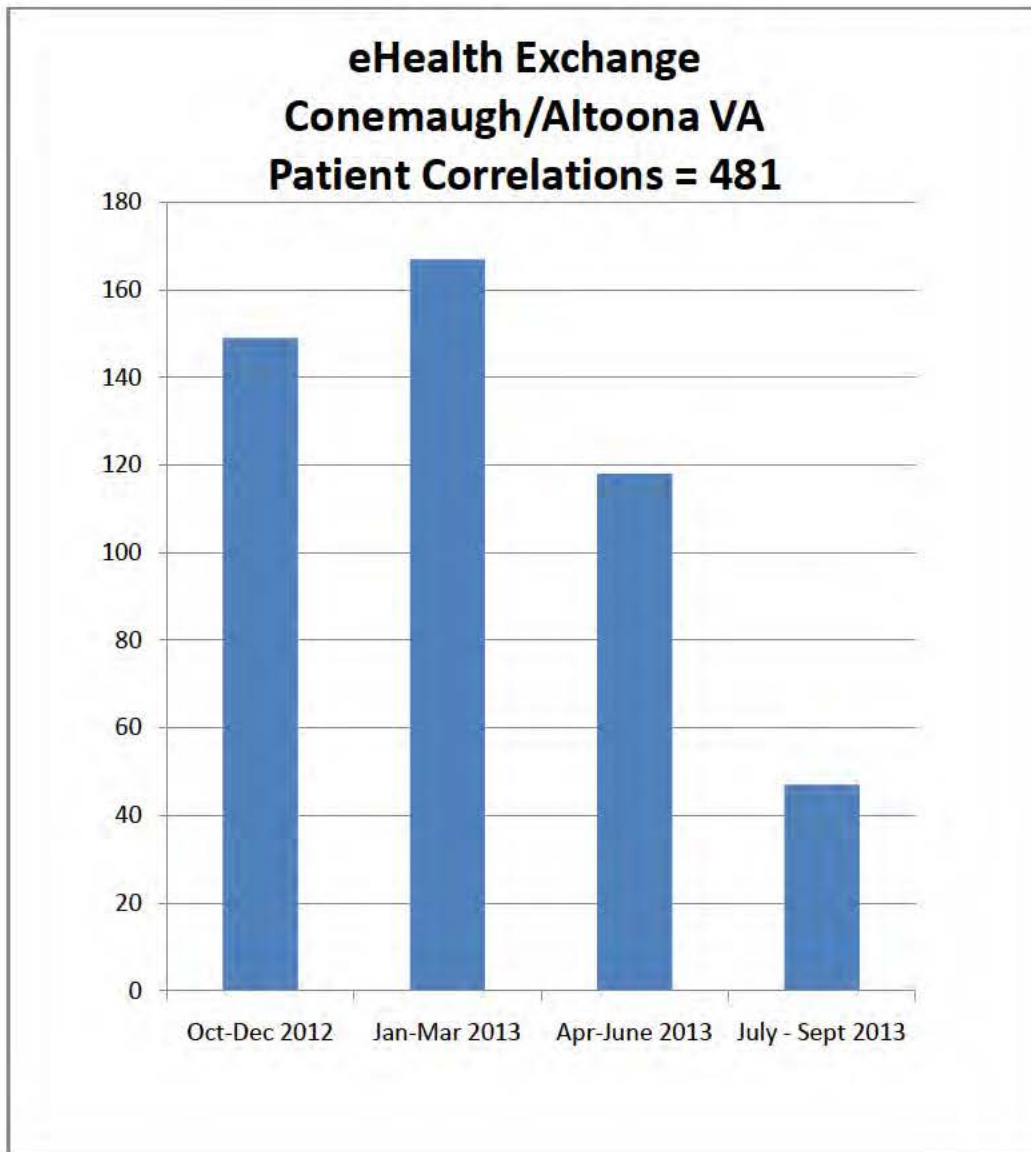
On September 19, 2013, Northrop Grumman helped the Jericho technical team establish a GoTo Meeting session that was used to support the Jericho/UT-Austin Pilot use-case demonstration. Northrop Grumman will provide support to Jericho until their contract expires.

**Subtask 2.4 Assess and analyze NHIN-related activities, to include data center performance metrics, physician evaluation and usage of the NHIN Portal, and resulting benefits of HIE with federal participants.**

#### Utilization Metrics

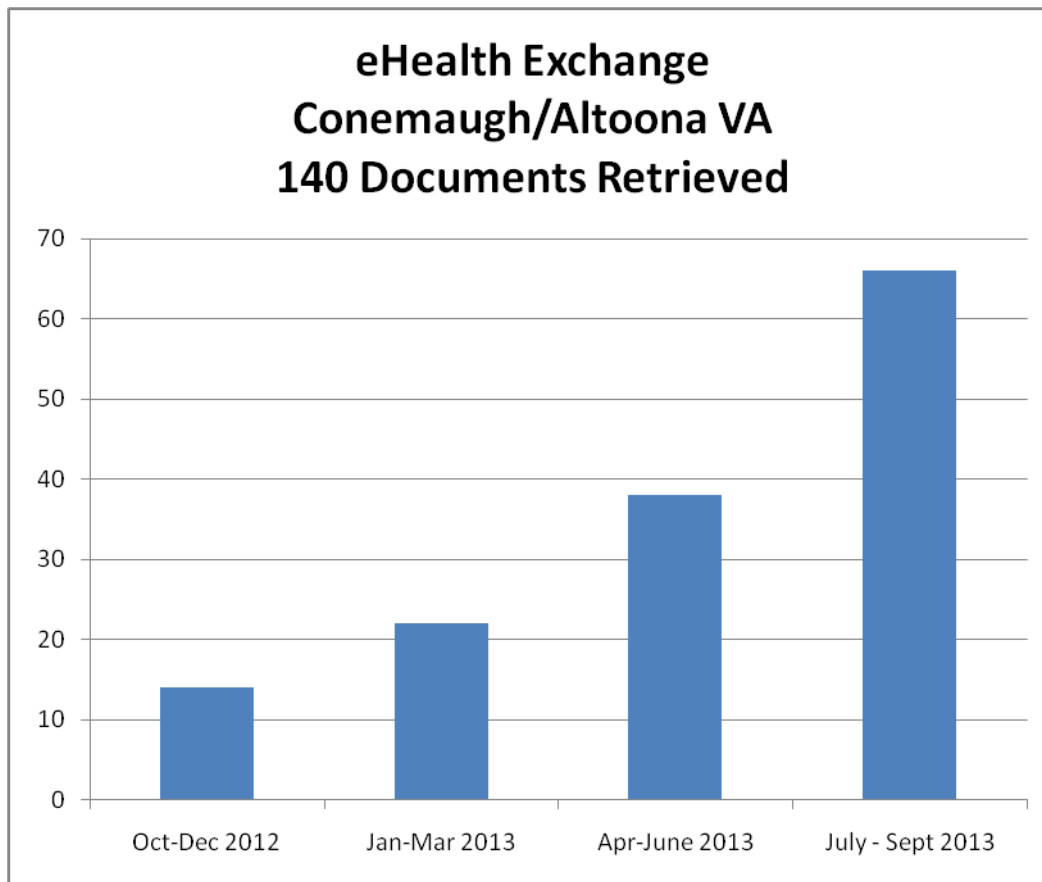
All organizational and IRB approvals were received during the previous year. On July 16, 2013, the Conemaugh IRB approved the continuation of the study for an additional year. On July 24, 2013, the U.S. Army Medical Research and Materiel Command's (USAMRMC) Office of Research Protections (ORP), Human Research Protection Office (ORP) acknowledged receipt of the continuing review documents and placed them in the protocol file.

Data collection continues with documentation of monthly transactions between Conemaugh and VA for treatment purposes as reported in Figures 20, 21 and 22 below. In addition, the number of sent invitations, returned authorizations and successful patient discovery correlations are documented in Table 18 and Figure 20 below. Northrop Grumman has provided monitoring statistics from the Glassfish server for much of the past year except for a two month period because the server unexpectedly stopped responding on July 23<sup>rd</sup>. The review and analysis of data center performance metrics is pending.



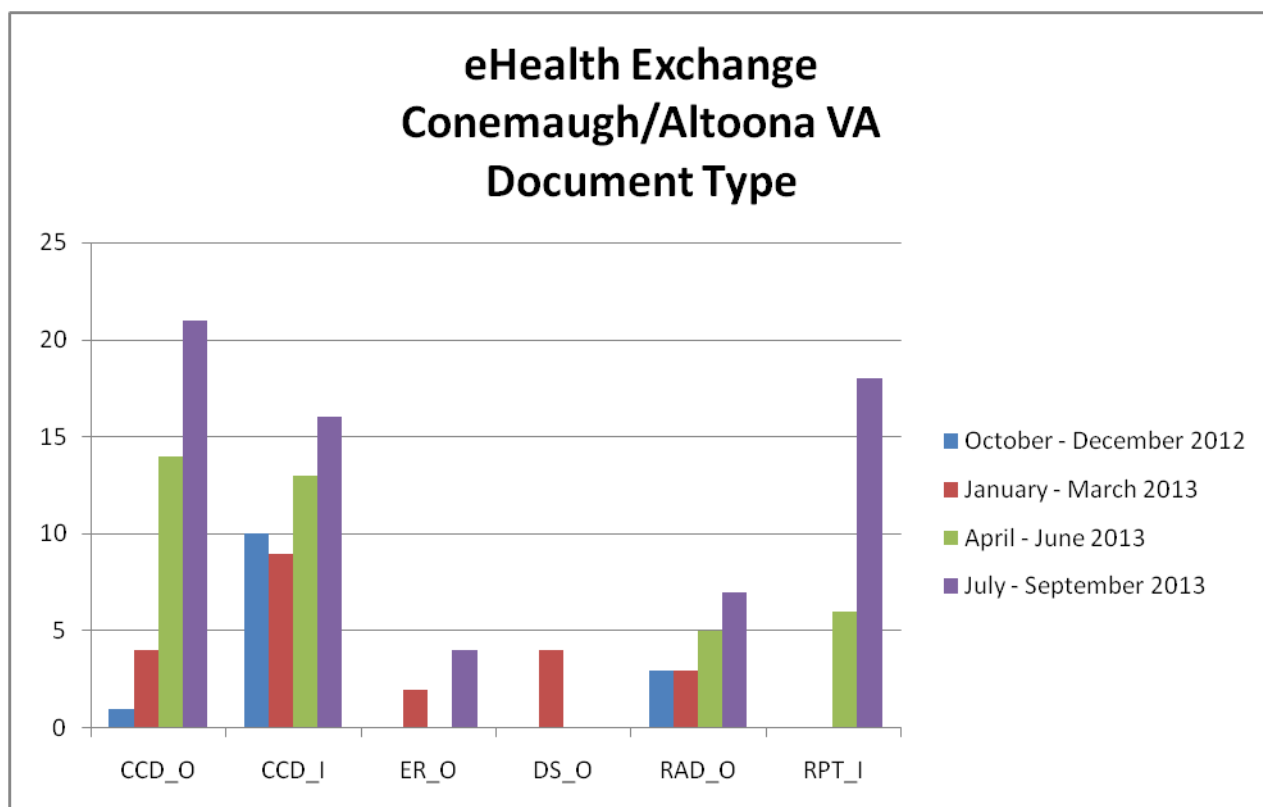
**Figure 20. Patient correlations during year.**

The increase in patient correlations has been positive and has been mainly dependent on patient response to the VLER packets sent via postal mail. It is important to note that failed correlations have been less than 5%, which is better than anecdotal concerns heard in other areas. This is likely due to the inclusion of Social Security Number used to make a match.



**Figure 21. Summary Count of Clinical Documents Retrieved.**

The increase in utilization is promising for the future of the eHealth Exchange and will likely increase after CMMC completes integration of lab data to the C32 document. The increase in documents retrieved is probably due to the flattening of the learning curve, the increase in patient correlations and the increase in users that have been trained on the new system(s).



**Figure 22. Clinical Documents Retrieved by Type and Direction.**

CCD\_I = Continuity of Care Document Inbound  
 CCD\_O = Continuity of Care Document Outbound  
 RAD\_O = Radiology Report Outbound  
 DS\_O = Discharge Summary Outbound  
 ER\_O = Emergency Room Note Outbound  
 RPT\_I = C62 Reports Inbound

Conemaugh providers prefer retrieving VA lab results and medication history via the continuity of care document (CCD). Retrieval of C62 reports from the VA has been minimal and was highly influenced by one user/day. Likewise, VA providers have preferred to retrieve the CCD from Conemaugh and also radiology reports. Retrieval of Emergency Room notes and discharge summaries have been minimal to date. Interestingly, the initiation of document retrievals is nearly a 50/50 split (Conemaugh N = 52, VA N= 48).

A total of 22 male veterans have responded to the health information exchange survey. Surveys have been sent to 37 veterans for whose health information has been exchanged in production. Below are descriptive results from a few important questions:

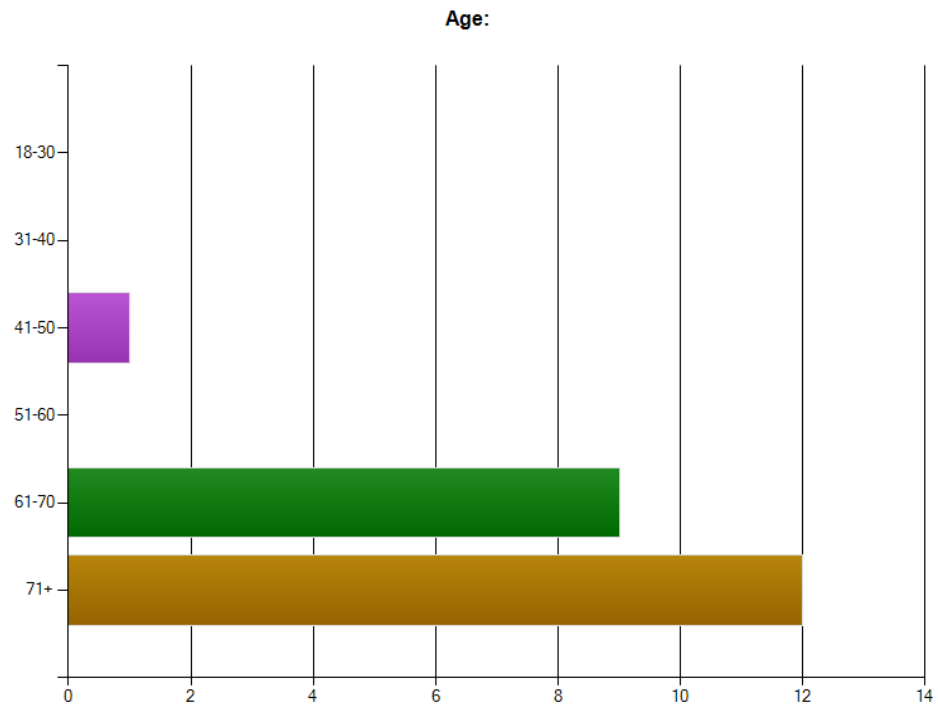


Figure 23. Survey respondent by age.

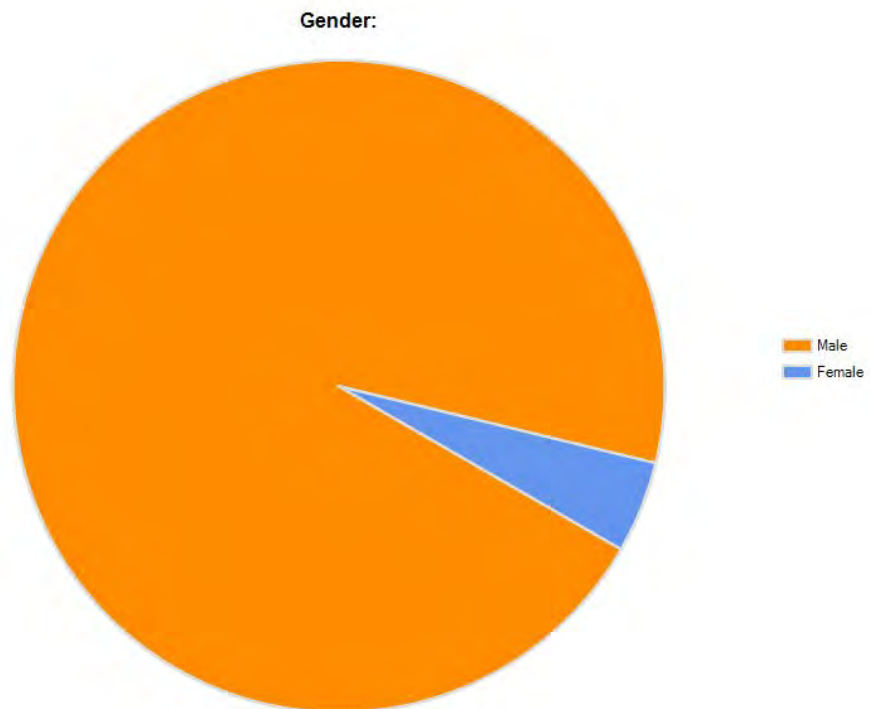


Figure 24. Survey respondent by gender.

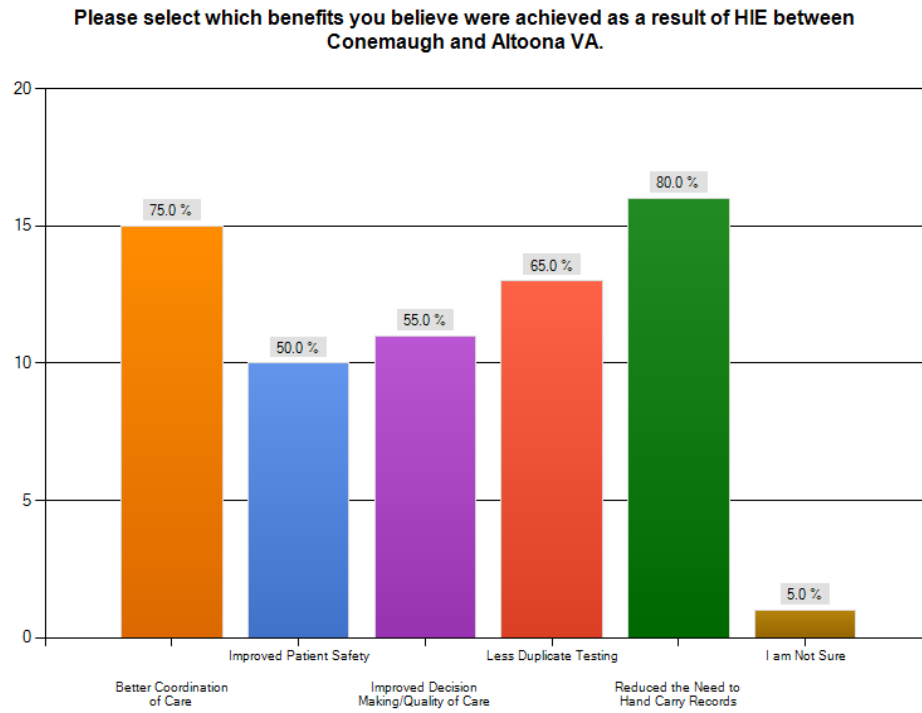


Figure 25. Patient perception of HIE benefits.

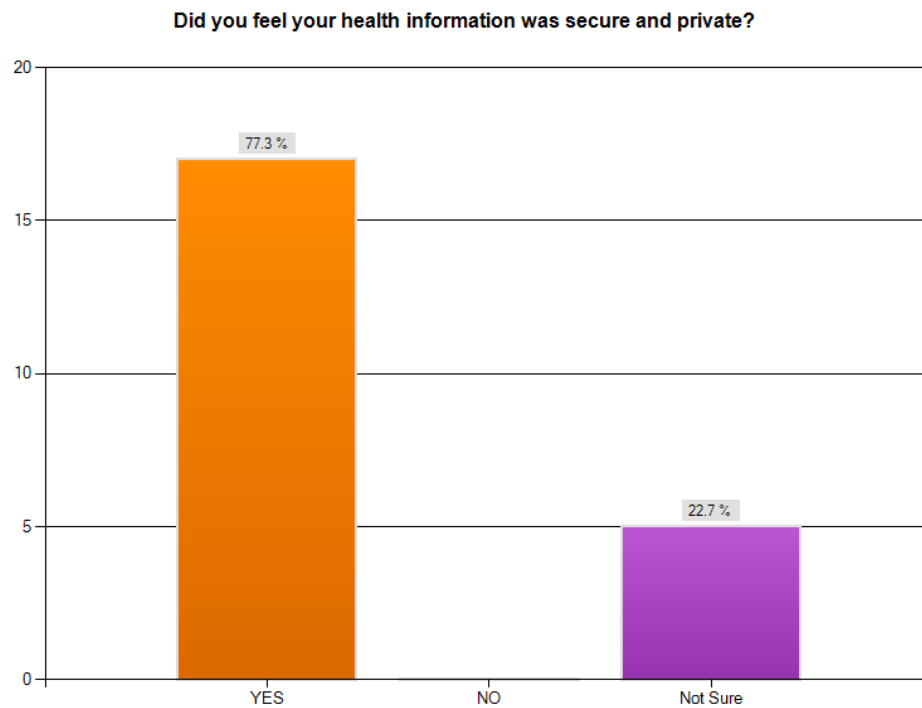
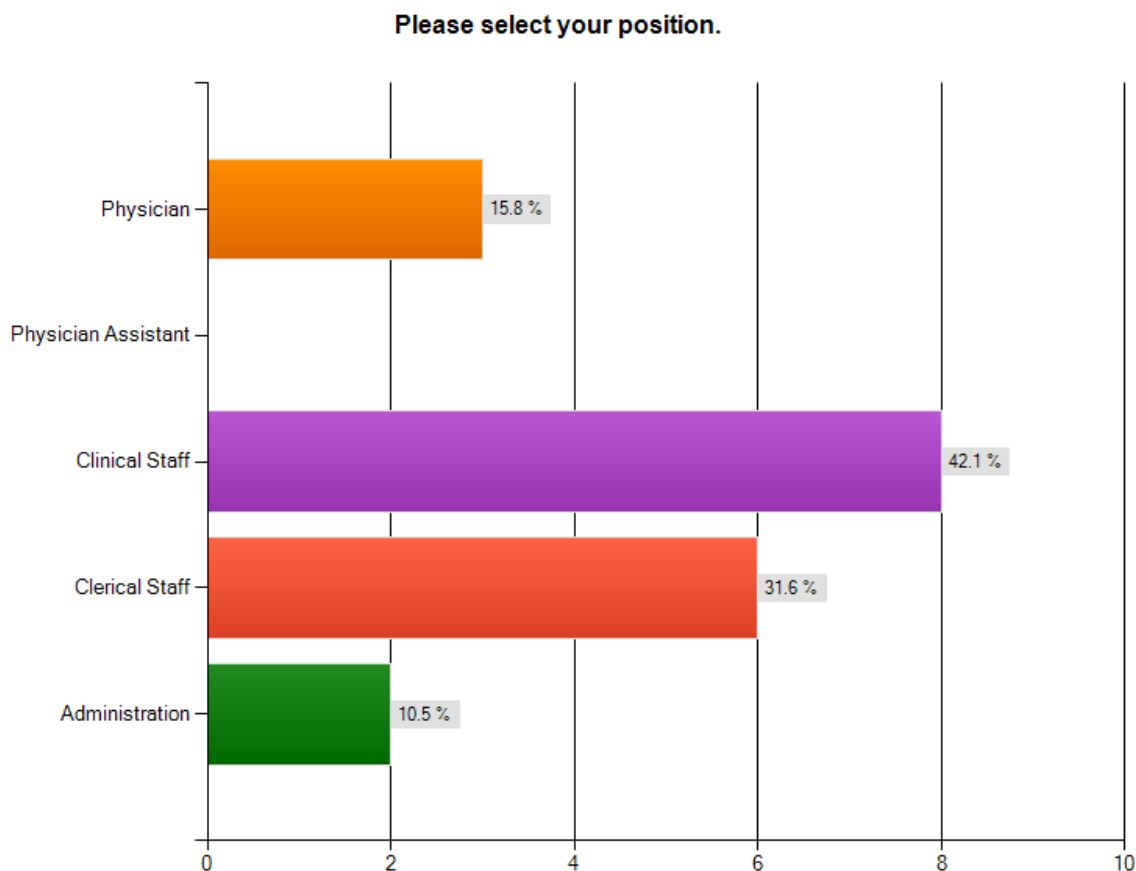


Figure 26. Data security and privacy.

The limited sample size of Veterans responding to the survey has had a positive experience with health information exchange between Altoona VA and Conemaugh. The majority of patients believe that coordination of care across providers has improved and has reduced the need for Veterans to hand carry their paper records to providers. More than half of survey respondents believe that decision making and quality of care has also improved and there is less duplicate testing because of the electronic exchange of medical information. Additional surveys will be distributed to grow the sample size.

A total of 19 Conemaugh Physician Group (CPG) providers have responded to the provider survey regarding health information exchange. The first six Conemaugh practices onboarded were given an opportunity to participate in the survey. VA has not provided permission yet to survey their staff. Please note only system users (n=11) were allowed to complete all questions. Below are results for a few important questions:



**Figure 27. Survey respondent by position.**

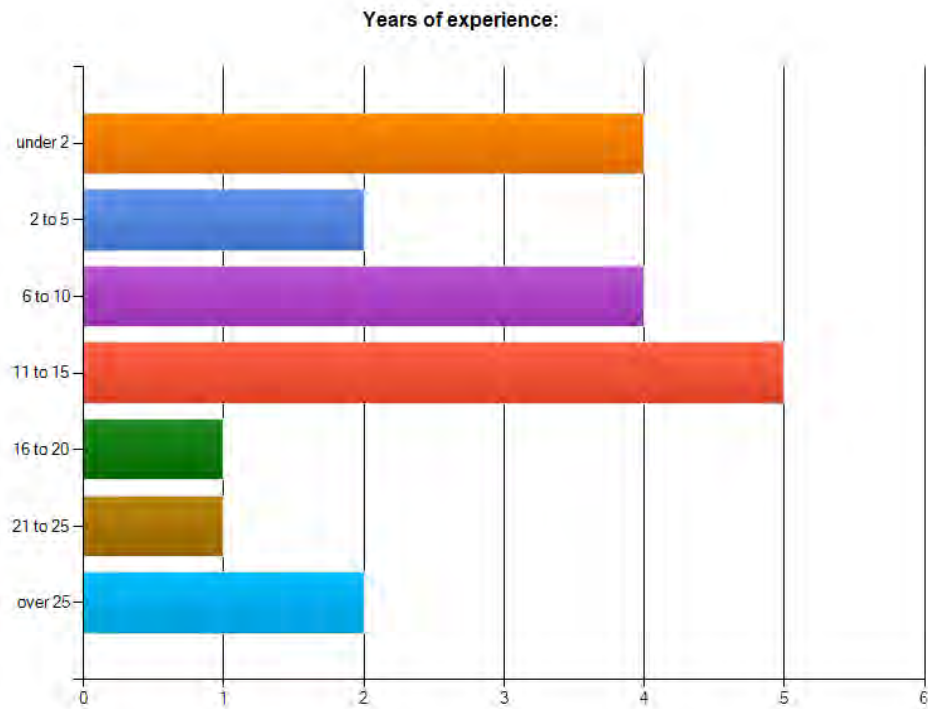


Figure 28. Survey respondent by experience.

Have you accessed patient health information through the NWHIN/VLER Exchange?

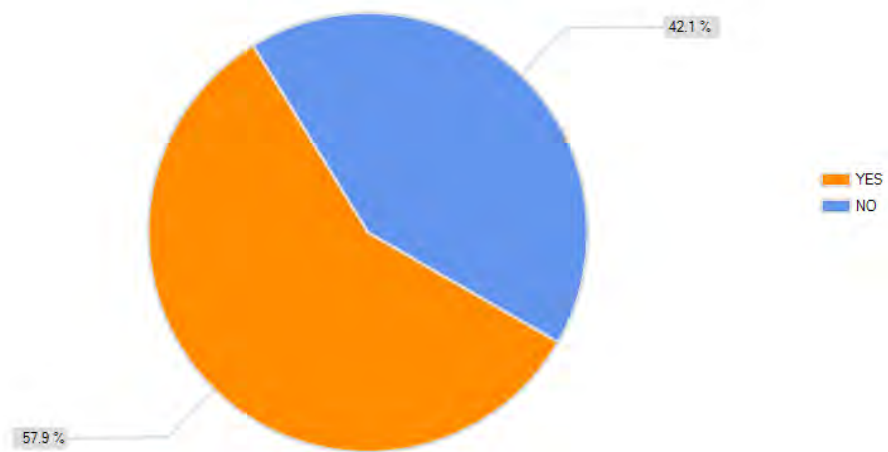


Figure 29. Provider access to the Exchange.

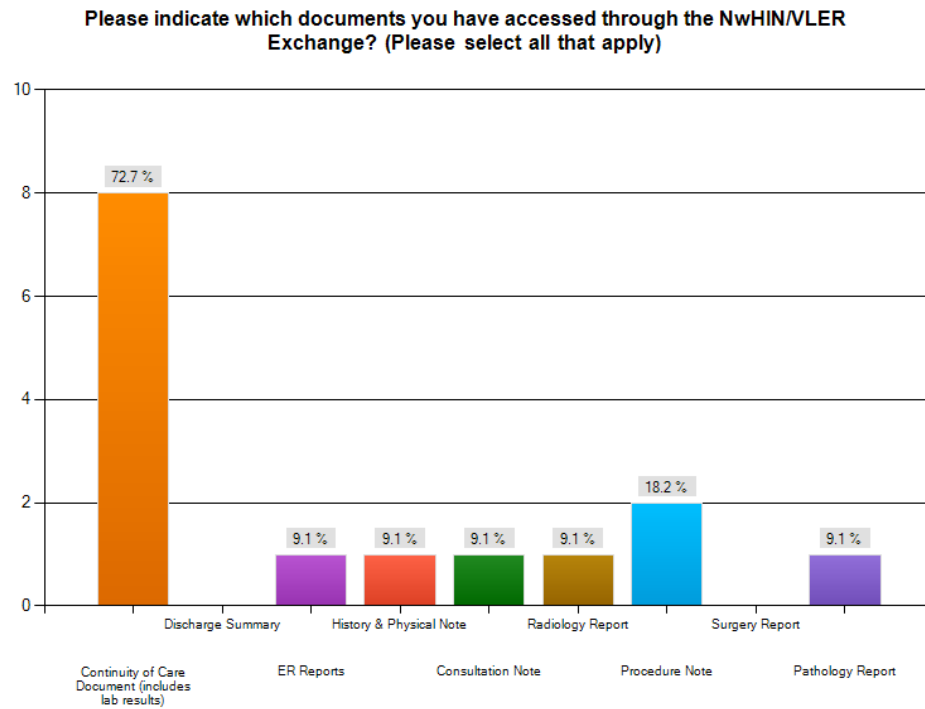


Figure 30. Type of clinical documents accessed.

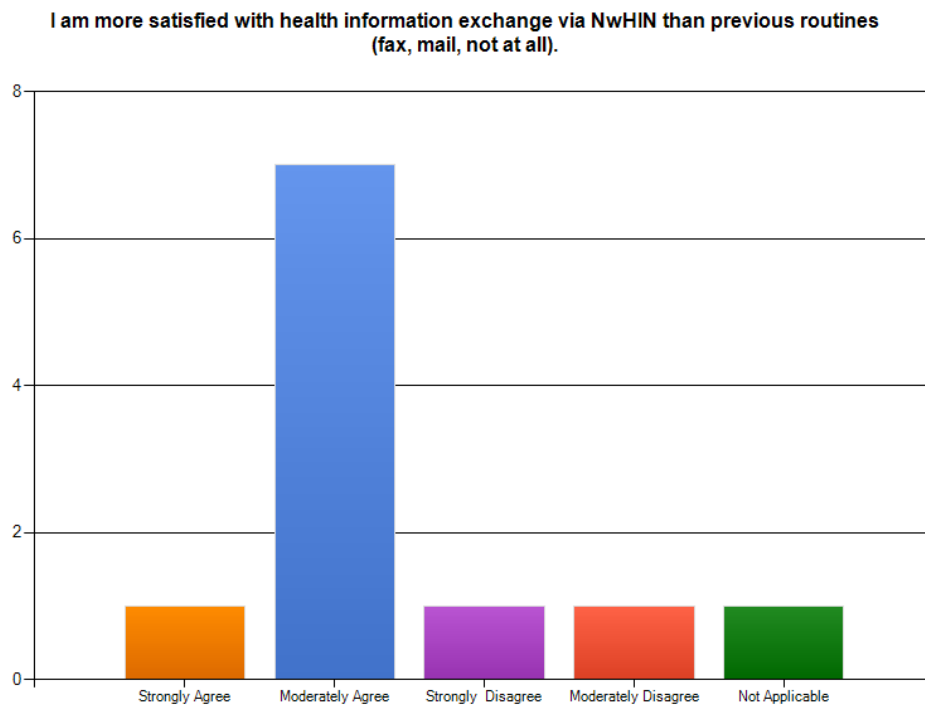


Figure 31. Provider satisfaction with HIE.

A few key observations are noted from survey results and personal interaction with providers. Clerical and nursing staffs are the primary users requesting data via the eHealth Exchange, only one CPG physician to date has been an active user. System usage would be higher but in some cases Veterans are still hand carrying their records, thus reducing the need to request information electronically. The most requested and important information to Conemaugh users is lab results performed by VA facilities. This fact promotes continuity of care and a reduction in duplicate testing. As aligned with patient input, providers believe coordination of care has improved and patients have less of a burden on them to hand carry paper records. Not surprisingly, all providers believed that electronic health information exchange has reduced the number of requests made to the VA medical records department. Over 80% of providers agree that the electronic exchange of health information is more satisfying than previous routines of fax, hard copy mail or not having the information at all.

## ***Key Research & Development Accomplishments***

### **Arm 1:**

- Completion of data collection and statistical analysis of staff and student nursing satisfaction of BCMA
- Completion of data collection and statistical analysis of pharmacy and nursing workflow analysis (time and motion)
- Intensive review of CMMC medication errors and interim statistical analysis
- Implementation of second MedCarousel in the pharmacy
- Implementation of McKesson BCMA analytics

### **Arm 2:**

- Increasing trend in patient correlations, system users and document exchanges
- Transitioned to CONNECT 3.3.1.3 gateway/adaptor in production
- First participant in nation to successfully pass new “eHealth Exchange” testing program
- One year in production phase with Altoona VA Medical Center/VLER

## ***Reportable Outcomes***

- Submission of MIDHT code to TATRC and Federal Health Architecture
- Public presentations at CONNECT Code-A-Thon in Maryland

## ***Conclusion***

The MIDHT project continues to implement and research health information technologies (HIT) within the Conemaugh Health System, located in Southwestern Pennsylvania. Core technologies under investigation include pharmacy robotics, bar code medication administration (BCMA) and health information exchange via the eHealth Exchange. Statement of work is being delivered as expected with few technology delays.

Significant progress has been made on both arms of the project. Research activities for Arm 1 have progressed, including an initial analysis on medication errors and completion of statistical testing on nursing workflow and satisfaction. CMMC is participating in the 14th Virtual Lifetime Electronic Record pilot nationwide via data exchange with the Altoona VA Medical Center (Arm 2). Patient correlations, system users and document exchange all have increased throughout the year. CMMC was the first participant in the nation to pass the new “eHealth Exchange” testing program (2010/2011 services).

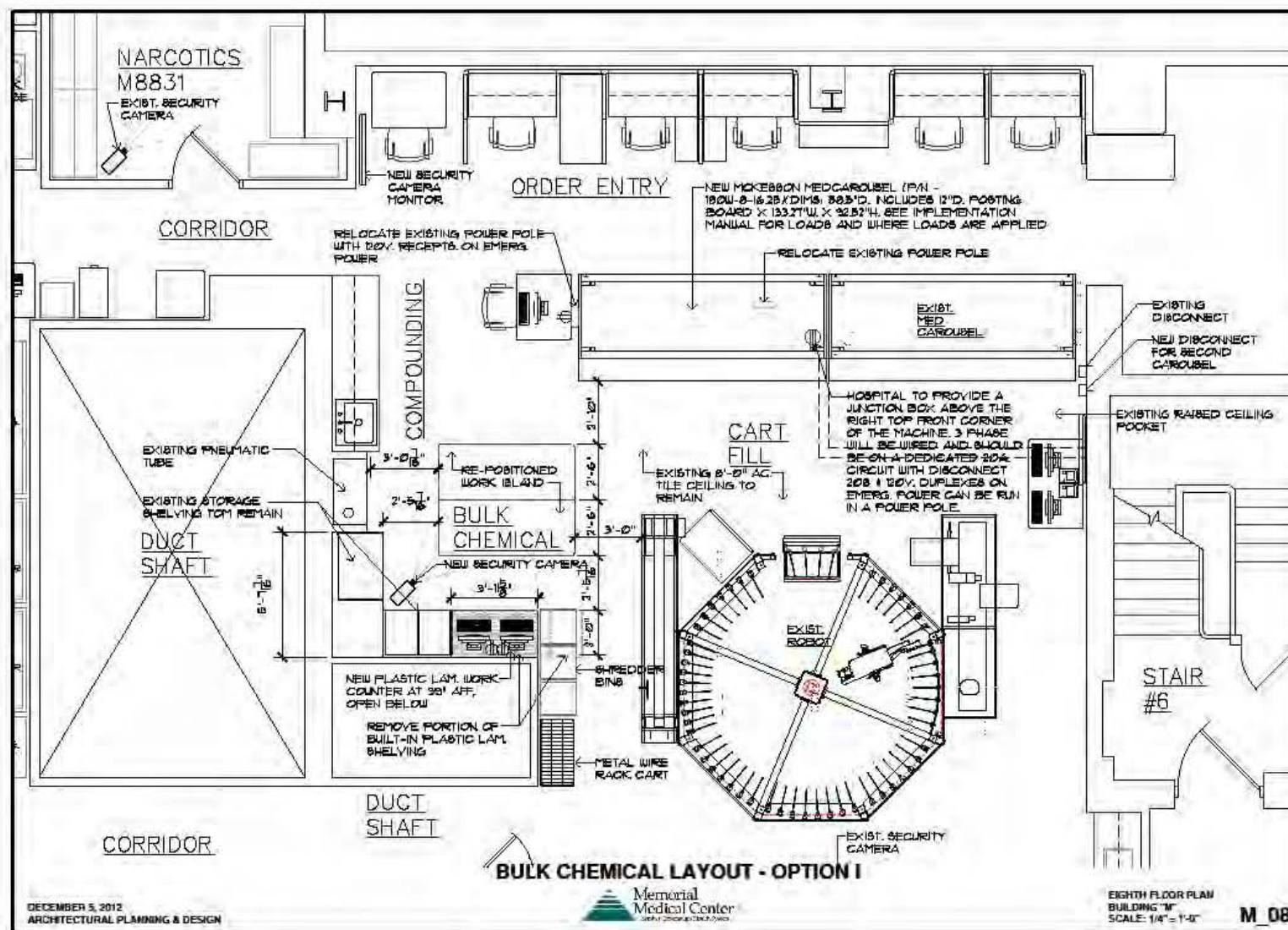
## ***Appendices***

### Appendix A – Acronym List

<b><u>Acronym</u></b>	<b><u>Description/Definition</u></b>
API	Application Programming Interface
BCMA	Bar Code Medication Administration
CAL	Common Access Layer
CHS	Conemaugh Health System
CMMC	Conemaugh Memorial Medical Center
COTS	Commercial Off The Shelf
CPP	Consumer Preferences Profile
CVMH	Conemaugh Valley Memorial Hospital (dba “CMMC”)
DQ	Document Query
DoD	Department of Defense
FHA	Federal Health Architecture
GUI	Graphical User Interface
HIE	Health Information Exchange
JIRA	Bug tracking software
LDAP	Lightweight Directory Access Protocol
MHS	Military Health System
MIMC	Conemaugh Miners Medical Center
MIDHT	Military Interoperable Digital Hospital Testbed
MIS	Management Information Systems
MPI	Master Patient Index
MYMC	Conemaugh Meyersdale Medical Center
NGC	Northrop Grumman Corporation
NwHIN	Nationwide Health Information Network (now called “eHealth Exchange”)
OID	Object Identifier
ONC	Office of the National Coordinator for HIT
OpenDS	Open Directory Service
PD	Patient Discovery
PHI	Protected Health Information
PMD	A static ruleset based Java source code analyzer that identifies potential problems
QD	Query for Documents
RCMR	Message for document metadata and content query/response
RD	Retrieve Documents
SAML	Security Access Markup Language
SAN	Storage Area Network
SOW	Statement of Work

SRM	Safety and Risk Management
SSO	Single Sign On
SVN	Subversion
TATRC	Telemedicine & Advanced Technology Research Center
UC	Universal Client
UDDI	Universal Description Discovery and Integration
USAMRMC	United States Army Medical Research and Materiel Command
VA	U.S. Department of Veterans Affairs
VAMC	Veterans Affairs Medical Center
VLER	Virtual Lifetime Electronic Record
VNX	Unified Storage Platform by EMC
VPN	Virtual Private Network
WSDL	Web Services Description Language
XDS	Cross-Enterprise Document Sharing

## Appendix 1 – MedCarousel 2 Layout



## Appendix 2 – BCMA Analytics Reports

### McK Adoption Horizon AdminRx Analytics

Entity: 01

Department: Show All

Refresh

Measure	Previous 5 Months					Current Month	Goal	Achievement
	Nov 2012	Dec 2012	Jan 2013	Feb 2013	Mar 2013			
	Medication Administration							
Total # of Med Admin Attempts	‡	‡	315,216*	184,894*	156,625*	36,156*		
% Med Admins Given	‡	‡	85.7%*	84.6%*	84.0%*	83.8%*		
% Med Admins w/Drug Barcode Scanned	‡	‡	95.7%*	95.0%*	94.3%*	94.5%*		
% Med Admins Given Early	‡	‡	3.6%*	4.1%*	5.0%*	4.3%*		
% Med Admins Given Late	‡	‡	14.1%*	15.8%*	16.7%*	16.7%*		
% Admins wNo Med Order Found Override	‡	‡	1.1%*	1.2%*	1.3%*	1.3%*		
% Admins w/ Quantity Override	‡	‡	0.7%*	0.7%*	0.7%*	0.6%*		
% Admins w/No Schedule Found Override	‡	‡	1.2%*	1.3%*	1.4%*	1.4%*		
	Medication Administration Warnings							
Total # of Med Admin Warnings	‡	‡	180,638*	126,397*	112,451*	25,483*		
% Med Admin Warnings Overridden	‡	‡	44.6%*	48.3%*	48.9%*	47.3%*		
% Med Admin Warnings Leading to Modify	‡	‡	52.4%*	48.7%*	48.5%*	49.8%*		
% Med Admin Warnings Leading to Cancel	‡	‡	52.4%*	48.7%*	48.5%*	49.8%*		
	IV Administration							
Total # of IV Administrations	‡	‡	13,345*	8,535*	8,866*	1,910*		
% IV Admin Starts	‡	‡	48.1%*	47.8%*	48.3%*	49.3%*		
% IV Starts w/ IV Barcode Scanned	‡	‡	71.3%*	63.3%*	66.2%*	70.5%*		
% IV Admins w/ Wristband Scanned	‡	‡	88.9%*	90.1%*	90.2%*	89.1%*		

McK Adoption HARx Analytics Medication Administration

Drill 1 of 8: Month Medication was Charted

<u>Month Medication was Charted</u>	Total Med Admin Attempts	Given	% Barcode Scanned	Schedule Override Count	% wSchedule Override	Drug Warning Override Count	Quantity Override Count	% wQuantity Override
2013_01_January	321,244	275,332	95.6%	3,305	1.2%	3,067	2,026	0.7%
2013_02_February	188,333	159,506	95.0%	2,005	1.3%	1,910	1,078	0.7%
2013_03_March	159,407	133,921	94.3%	1,831	1.4%	1,689	954	0.7%
2013_04_April	16,363	13,612	94.8%	208	1.5%	197	69	0.5%
Report Total	685,347	582,371	95.1%	7,349	1.3%	6,863	4,127	0.7%

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IT Adoption Horizon Admin Rx Analytics 1.2

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Display • Alerts • Drill Up • Drill Top • Export • Print • Preferences • Startup

## McK Adoption HARx Analytics Medication Administration

Drill 1 of 8: Month Medication was Charted

Drill 2 of 8: Primary Medication Name; from Month Medication was Charted / 2013\_03\_March

Page 1 of 8 [ 1 2 3 4 5 6 7 8 ]

Primary Medication Name	Total Med Admin Attempts	Given	% Given	Barcode Scanned Count	% Barcode Scanned	Schedule Override Count	% wSchedule Override	Drug Warning Override Count	% wDrug Warning Override	Given Late	% Given Late	Given Early	% Given Early
METOPROLOL TARTRATE	2,904	2,552	87.9%	2,332	91.4%	11	0.4%	11	0.4%	480	18.8%	49	1.9%
SODIUM CHLORIDE 0.9 %	2,899	1,952	67.3%	1,720	88.1%	144	7.4%	146	7.5%	459	23.5%	7	0.4%
INSULIN LISPRO	2,779	2,515	90.5%	2,344	93.2%	22	0.9%	15	0.6%	82	3.3%	6	0.2%
POTASSIUM CHLORIDE	1,808	1,579	87.3%	1,547	98.0%	11	0.7%	11	0.7%	474	30.0%	22	1.4%
ENOXAPARIN SODIUM	1,745	1,570	90.0%	1,543	98.3%	1	0.1%	1	0.1%	476	30.3%	57	3.6%
HEPARIN SODIUM (PORCINE)	1,743	1,578	90.5%	1,546	98.0%	10	0.6%	11	0.7%	213	13.5%	61	3.9%
LORAZEPAM	1,664	1,534	92.2%	1,460	95.2%	42	2.7%	37	2.4%	130	8.5%	68	4.4%
ACETAMINOPHEN	1,639	1,567	95.6%	1,526	97.4%	18	1.1%	12	0.8%	67	4.3%	12	0.8%
GABAPENTIN CAP	1,583	1,492	94.3%	1,487	99.7%	0	0.0%	0	0.0%	218	14.6%	90	6.0%
SIMVASTATIN	1,478	1,411	95.5%	1,396	98.9%	1	0.1%	1	0.1%	153	10.8%	114	8.1%
FENTANYL CITRATE (PF)	1,424	1,404	98.6%	1,241	88.4%	91	6.5%	86	6.1%	4	0.3%	0	0.0%
OXYCODONE	1,372	1,317	96.0%	1,299	98.6%	2	0.2%	2	0.2%	86	6.5%	12	0.9%
ACETAMINOPHEN TAB	1,362	1,310	96.0%	1,299	98.4%	15	1.1%	12	0.9%	28	2.7%	0	0.0%

### McK Adoption HARx Analytics Medication Administration

Drill 1 of 8: Month Medication was Charted

Drill 2 of 8: Primary Medication Name; from Month Medication was Charted / 2013\_03\_March

Drill 3 of 8: Department where Medication was Given; from Primary Medication Name / LORAZEPAM

Department where Medication was Given	Total Med Admin Attempts	Given	% Given	Barcode Scanned Count	% Barcode Scanned	Schedule Override Count	% wSchedule Override	Drug Warning Override Count	% wDrug Warning Override	Given Late	% Given Late	Given Early	% Given Early
G4	184	170	92.4%	156	91.8%	4	2.4%	4	2.4%	11	6.5%	5	2.9%
G7	167	154	92.2%	130	84.4%	2	1.3%	2	1.3%	29	18.8%	2	1.3%
R1	128	95	74.2%	90	94.7%	0	0.0%	0	0.0%	5	5.3%	3	3.2%
A1	123	113	91.9%	111	98.2%	1	0.9%	1	0.9%	9	8.0%	6	5.3%
G5	101	96	95.0%	91	94.8%	2	2.1%	2	2.1%	8	8.3%	2	2.1%
G6	97	94	96.9%	92	97.9%	2	2.1%	2	2.1%	12	12.8%	3	3.2%
A8	92	87	94.6%	86	98.9%	1	1.1%	1	1.1%	7	8.0%	1	1.1%
E4	73	71	97.3%	69	97.2%	1	1.4%	0	0.0%	7	9.9%	2	2.8%
A6	68	64	94.1%	61	95.3%	4	6.3%	4	6.3%	1	1.6%	1	1.6%
R8	64	55	85.9%	54	98.2%	1	1.8%	1	1.8%	2	3.6%	3	5.5%
R9	59	58	98.3%	52	89.7%	0	0.0%	0	0.0%	3	5.2%	1	1.7%
E6	50	48	96.0%	47	97.9%	2	4.2%	1	2.1%	2	4.2%	0	0.0%
M7	44	39	88.6%	38	97.4%	0	0.0%	0	0.0%	3	7.7%	0	0.0%
7R	39	35	89.7%	33	94.3%	15	42.9%	13	37.1%	2	5.7%	0	0.0%
A9	28	25	89.3%	22	88.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
MF	18	17	94.4%	16	94.1%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
S5	7	6	85.7%	5	83.3%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
<b>Total</b>	<b>1,342</b>	<b>1,227</b>	<b>91.4%</b>	<b>1,153</b>	<b>94.0%</b>	<b>35</b>	<b>2.9%</b>	<b>31</b>	<b>2.5%</b>	<b>101</b>	<b>8.2%</b>	<b>29</b>	<b>2.4%</b>

## **Appendix 3 – BCMA Survey Instrument**

# Medication Administration System Survey – Nurses' Assessment Survey

## 1. Welcome

Thank you for participating in the Medication Administration System Survey –

Nurses' Assessment Survey (MAS-NAS) project.

Completing this form indicates you recognize that this is a research project. As a token of our appreciation, you will receive a \$20.00 incentive from Crossroads café or similar venue when you have completed the survey. After completion, please call 814-269-5232 to arrange receipt and please have your "SUM" available. We reserve the right to withhold incentive for any reason related but not limited to that which compromises the survey intent, data validity, completion compliance, or respondent eligibility.

If you previously completed a MAS-NAS, please complete this survey so we can learn how barcode/eMAR has changed how you administer medications. We will compare nurses' responses on this MAS-NAS with previous surveys completed in 2011 and 2012 to learn the impact of converting to barcode/eMAR on CHS nurses.

If this is your first MAS-NAS, we would like to learn your beliefs about the system.

Please create a five digit confidential identifier called SUM. This allows us to maintain your privacy while being able to compare surveys taken at different times. Even if this is your first survey, please compute your SUM. We ask you to calculate the following number and place it in the space provided. The number is the SUM of the last five digits of your social security number added to the last five digits of your home telephone number. If your telephone number changed, please use the number you previously used. Only the SUM of those two numbers should be recorded on the first page of the survey. If your sum has more than five digits, record only the last five. See example below.

Last five social security numbers = 52346

+

Last five home telephone numbers = 58721

SUM = 111067

ENTER 11067 (last five)

After calculating your SUM, please:

Add your SUM on the next page and complete the survey.

Thank you for your participation in this important project!

## 2. Introduction

### \* 1. SUM:

### \* 2. Date of completing the survey:

## Medication Administration System Survey – Nurses' Assessment Survey

### \*3. Nursing Unit:

- ☐ Meyersdale Medical Center
- ☐ Miners Medical Center
- ☐ Ashman 6 ICU
- ☐ Ashman 7
- ☐ Ashman 8
- ☐ Ashman 9
- ☐ Ashman 10
- ☐ Rose 6 ICU
- ☐ Rose 7 CICU
- ☐ Rose 7 Telemetry
- ☐ Rose 8
- ☐ Rose 8 PCU
- ☐ Rose 9
- ☐ Rose 10
- ☐ E4
- ☐ E6
- ☐ GS 4
- ☐ GS 5
- ☐ GS 6
- ☐ ASU
- ☐ PACU
- ☐ Crichton Rehab
- ☐ Med Surg 7
- ☐ RICN
- ☐ Maternity
- ☐ Pediatrics
- ☐ Geropysch
- ☐ Aloysia Hall
- ☐ Behavioral Health
- ☐ School of Nursing
- ☐ Float

## Medication Administration System Survey – Nurses' Assessment Survey

☐ TCU

Other (please specify)

The following statements describe experiences and beliefs about the current medication administration system you use. By current medication administration system, we mean the institutional structures and operational policies that direct and support the process and procedures of delivering/administering pharmaceutical products to patients. This includes all activities from medication ordering to dispensing to administration and documentation as well as all supplies and technologies associated with the current medication system, such as computer terminals, medication storage units, drug/drug interaction information, patient education sheets, infusion pumps, tubings, syringes, etc that are required in the process of getting medications to patients.

Completing this survey should take about 10 minutes.

By completing this survey, you are indicating consent to participate in this evaluation.

Please read each statement and circle the number that best expresses your own experiences and beliefs.

There are no right or wrong answers.

Do not write your name on the survey.

Please indicate the degree to which you agree or disagree with each item by using the following RATING SCALE.

Choose:

1 if you strongly agree with the statement.

2 if you moderately agree with the statement.

3 if you slightly agree with the statement.

4 if you slightly disagree with the statement.

5 if you moderately disagree with the statement.

6 if you strongly disagree with the statement.

NA if the statement does not apply to you.

Example: The current medication administration system provides adequate information about possible medication side effects.

Answer: If you believe that you always have access to the type and amount of information you need to be able to assess for and manage potential side effects of medications you administer, you should circle 1 because that statement best expresses your belief.

### 3. Questions

**4. Because of information available through the current medication administration system I know both the intended actions and side effects of medications I administer.**

☐ 1   ☐ 2   ☐ 3   ☐ 4   ☐ 5   ☐ 6   ☐ NA  
Strongly   Moderately   Slightly   Slightly   Moderately   Strongly   Not  
Agree   Agree   Agree   Disagree   Disagree   Disagree   Applicable

**5. I find the drug alert feature (drug/drug or drug/food interaction) of the current medication administration system helpful.**

☐ 1   ☐ 2   ☐ 3   ☐ 4   ☐ 5   ☐ 6   ☐ NA  
Strongly   Moderately   Slightly   Slightly   Moderately   Strongly   Not  
Agree   Agree   Agree   Disagree   Disagree   Disagree   Applicable

## Medication Administration System Survey – Nurses' Assessment Survey

**6. The current medication administration system makes it easy to check active medication orders before administering medications.**

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ NA  
Strongly Moderately Slightly Slightly Moderately Strongly Not  
Agree Agree Agree Disagree Disagree Disagree Applicable

**7. The current medication administration system provides me with information to know that a medication order has been checked by a pharmacist before I administer the medication.**

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ NA  
Strongly Moderately Slightly Slightly Moderately Strongly Not  
Agree Agree Agree Disagree Disagree Disagree Applicable

**8. The current medication administration system promotes 2-way communication between clinicians (MD, Pharmacist, RN) about medication orders.**

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ NA  
Strongly Moderately Slightly Slightly Moderately Strongly Not  
Agree Agree Agree Disagree Disagree Disagree Applicable

**4.**

**9. I have access to the systems that support medication administration (physician's orders, drug information) when I need them.**

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ NA  
Strongly Moderately Slightly Slightly Moderately Strongly Not  
Agree Agree Agree Disagree Disagree Disagree Applicable

**10. The drug information available through the current medication administration system is easy to get when I need that information.**

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ NA  
Strongly Moderately Slightly Slightly Moderately Strongly Not  
Agree Agree Agree Disagree Disagree Disagree Applicable

## Medication Administration System Survey – Nurses' Assessment Survey

**11. I know where all the medications I need are stored (either on the unit or if they need to be procured from the pharmacy).**

<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> 6	<input type="radio"/> NA
Strongly Agree	Moderately Agree	Slightly Agree	Slightly Disagree	Moderately Disagree	Strongly Disagree	Not Applicable

**12. The current medication administration system helps me to be efficient at medication administration.**

<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> 6	<input type="radio"/> NA
Strongly Agree	Moderately Agree	Slightly Agree	Slightly Disagree	Moderately Disagree	Strongly Disagree	Not Applicable

**13. The current medication administration system makes it easy to check that I am following the “5 rights” when I administer medications.**

<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> 6	<input type="radio"/> NA
Strongly Agree	Moderately Agree	Slightly Agree	Slightly Disagree	Moderately Disagree	Strongly Disagree	Not Applicable

**14. The turnaround time for receiving medications needed “stat” or for patients newly admitted to the unit is adequate.**

<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> 6	<input type="radio"/> NA
Strongly Agree	Moderately Agree	Slightly Agree	Slightly Disagree	Moderately Disagree	Strongly Disagree	Not Applicable

**15. The current medication administration system is effective in reducing and preventing medication errors.**

<input type="radio"/> 1	<input type="radio"/> 2	<input type="radio"/> 3	<input type="radio"/> 4	<input type="radio"/> 5	<input type="radio"/> 6	<input type="radio"/> NA
Strongly Agree	Moderately Agree	Slightly Agree	Slightly Disagree	Moderately Disagree	Strongly Disagree	Not Applicable

**16. The current medication administration system is user-friendly to the nurses who administer medications.**

<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> NA
Strongly Agree	Moderately Agree	Slightly Agree	Slightly Disagree	Moderately Disagree	Strongly Disagree	Not Applicable

## Medication Administration System Survey – Nurses' Assessment Survey

**17. The equipment and/or supplies needed to administer medications are readily available to me.**

- |                         |                         |                         |                         |                         |                         |                          |
|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|--------------------------|
| <input type="radio"/> 1 | <input type="radio"/> 2 | <input type="radio"/> 3 | <input type="radio"/> 4 | <input type="radio"/> 5 | <input type="radio"/> 6 | <input type="radio"/> NA |
| Strongly Agree          | Moderately Agree        | Slightly Agree          | Slightly Disagree       | Moderately Disagree     | Strongly Disagree       | Not Applicable           |

**18. Information available through the current medication administration system helps me to know what to do should my patient have any bad reactions from a medication.**

- |                         |                         |                         |                         |                         |                         |                          |
|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|--------------------------|
| <input type="radio"/> 1 | <input type="radio"/> 2 | <input type="radio"/> 3 | <input type="radio"/> 4 | <input type="radio"/> 5 | <input type="radio"/> 6 | <input type="radio"/> NA |
| Strongly Agree          | Moderately Agree        | Slightly Agree          | Slightly Disagree       | Moderately Disagree     | Strongly Disagree       | Not Applicable           |

**19. I have to keep stashes of medications to be sure I have medications I need when I need them.**

- |                         |                         |                         |                         |                         |                         |                          |
|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|--------------------------|
| <input type="radio"/> 1 | <input type="radio"/> 2 | <input type="radio"/> 3 | <input type="radio"/> 4 | <input type="radio"/> 5 | <input type="radio"/> 6 | <input type="radio"/> NA |
| Strongly Agree          | Moderately Agree        | Slightly Agree          | Slightly Disagree       | Moderately Disagree     | Strongly Disagree       | Not Applicable           |

### 5. Open-ended

**20. Please add any comments you wish about the current medication administration system and the degree to which components of the current system support your ability to administer medications safely and professionally.**

**21. If you could change one thing in the current medication administration system, what would it be?**

### 6. BCMA

## Medication Administration System Survey – Nurses' Assessment Survey

**22. Did you work on an inpatient nursing unit at CHS before BCMA (Admin-Rx) was implemented?**

☐ Yes

☐ No

**7.**

Comparing now (using barcode/eMAR) with the old system, please respond to the following 7 statements.

**23. It is easier to do all the checking steps needed during the medication administration process.**

☐ Strongly Agree

☐ Moderately Agree

☐ Slightly Agree

☐ Slightly Disagree

☐ Moderately Disagree

☐ Strongly Disagree

☐ Did not use old system

**24. This is a safer system for patients.**

☐ Strongly Agree

☐ Slightly Disagree

☐ Did not use old system

☐ Moderately Agree

☐ Moderately Disagree

☐ Slightly Agree

☐ Strongly Disagree

**25. With the new system, it is easier to access information I need to administer medications.**

☐ Strongly Agree

☐ Slightly Disagree

☐ Did not use old system

☐ Moderately Agree

☐ Moderately Disagree

☐ Slightly Agree

☐ Strongly Disagree

**26. I am more satisfied with this new medication administration system than with the previous one.**

☐ Strongly Agree

☐ Slightly Disagree

☐ Did not use old system

☐ Moderately Agree

☐ Moderately Disagree

☐ Slightly Agree

☐ Strongly Disagree

**27. I have more time to spend with patients.**

☐ Strongly Agree

☐ Slightly Disagree

☐ Did not use old system

☐ Moderately Agree

☐ Moderately Disagree

☐ Slightly Agree

☐ Strongly Disagree

## Medication Administration System Survey – Nurses' Assessment Survey

### 28. Barcode/eMAR has made the medication administration process more efficient for me.

- ☐ Strongly Agree      ☐ Slightly Disagree      ☐ Did not use old system  
☐ Moderately Agree      ☐ Moderately Disagree  
☐ Slightly Agree      ☐ Strongly Disagree

### 29. Medications are more readily available when I need them for patients.

- ☐ Strongly Agree      ☐ Slightly Disagree      ☐ Did not use old system  
☐ Moderately Agree      ☐ Moderately Disagree  
☐ Slightly Agree      ☐ Strongly Disagree

## 8. Closing

### \*30. Overall, how satisfied are you with the current medication administration system? Please select.

- ☐ 1 - Completely Dissatisfied    ☐ 2    ☐ 3    ☐ 4    ☐ 5 - Neither satisfied nor dissatisfied    ☐ 6    ☐ 7    ☐ 8    ☐ 9    ☐ 10 - Completely Satisfied

### \*31. How long have you been using the BCMA system (Admin-Rx) with patients?

- ☐ Less than 1 month      ☐ 4-6 months      ☐ 10-12 months  
☐ 1-3 months      ☐ 7-9 months

Please provide the following information about yourself and your background.

### 32. Gender:

- ☐ Male      ☐ Female

### 33. Age:

### 34. Highest nursing degree:

- ☐ LPN      ☐ Diploma      ☐ AS/AD      ☐ BS/BSN      ☐ MS/MSN

### 35. Number of years employed as a nurse:

### \*36. Number of years employed by Conemaugh:

## Medication Administration System Survey – Nurses' Assessment Survey

### 37. Number of hours worked in a typical week:

### 38. Typical shift rotation schedule:

- |                                  |                                  |                             |
|----------------------------------|----------------------------------|-----------------------------|
| <input type="radio"/> All Shifts | <input type="radio"/> Rotate D/E | <input type="radio"/> 7A-7P |
| <input type="radio"/> Evenings   | <input type="radio"/> Rotate D/N | <input type="radio"/> 7P-7A |
| <input type="radio"/> Nights     | <input type="radio"/> All Days   |                             |

### 39. Typical weekly schedule:

- |  |   |
|--|---|
| <input type="radio"/> mostly weekend/holiday | <input type="radio"/> rotate weekdays/weekends/holidays |
| <input type="radio"/> mostly Monday-Friday   |   |

### \*40. Current position:

- |  |                                 |
|--|---------------------------------|
| <input type="radio"/> staff/direct patient care (staff RN/NIC) | <input type="radio"/> education |
| <input type="radio"/> leadership/management                    | <input type="radio"/> Student   |

Other (please specify)

### 41. Compared to your nursing peers, how do you rate your computer skills?

- |                                     |                               |                                     |
|-------------------------------------|-------------------------------|-------------------------------------|
| <input type="radio"/> Above Average | <input type="radio"/> Average | <input type="radio"/> Below Average |
|-------------------------------------|-------------------------------|-------------------------------------|

### 42. Do you use a computer at home?

- |                           |                          |
|---------------------------|--------------------------|
| <input type="radio"/> Yes | <input type="radio"/> No |
|---------------------------|--------------------------|

### 43. How do you rate your skill at obtaining patient care information from the Conemaugh computer systems?

- |                                 |                            |                            |                            |
|---------------------------------|----------------------------|----------------------------|----------------------------|
| <input type="radio"/> Excellent | <input type="radio"/> Good | <input type="radio"/> Fair | <input type="radio"/> Poor |
|---------------------------------|----------------------------|----------------------------|----------------------------|

### 44. Did you ever use barcode/eMAR in another hospital before working at CHS?

- |                           |                          |
|---------------------------|--------------------------|
| <input type="radio"/> Yes | <input type="radio"/> No |
|---------------------------|--------------------------|

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## Appendix 4 – Nurse Shadowing

### Memorial Medical Center (CMMC)

CMMC PRE (N = 26 observations - RN):

<b>Nurse Shadowing: Study Time Period = PRE, Location = MMC</b>									
<b>Processes ranked by Total Time per PID</b>						<b>PID ranked by Count</b>			
<b>PID</b>	<i>cumulative time, hh:mm:ss</i>	<i>cumulative % of time</i>	<i>% of Total Time per PID</i>	<b>Total Time / PID, hh:mm:ss</b>	<b>PID</b>	<b>PID</b>	<b>Count of Activity IDs</b>	<i>avg. time / AID, hh:mm:ss</i>	
<b>4</b>	20:48:13	19.7%	19.7%	20:48:13	<b>4</b>	4	1290	0:00:58	
<b>1</b>	37:50:29	35.9%	16.2%	17:02:16	<b>1</b>	7	1217	0:00:33	
<b>2</b>	53:28:41	50.8%	14.8%	15:38:12	<b>2</b>	1	987	0:01:02	
<b>3</b>	68:09:45	64.7%	13.9%	14:41:04	<b>3</b>	9	600	0:00:50	
<b>7</b>	79:14:10	75.2%	10.5%	11:04:25	<b>7</b>	3	559	0:01:35	
<b>9</b>	87:35:16	83.1%	7.9%	8:21:06	<b>9</b>	2	252	0:03:43	
<b>10</b>	92:57:44	88.2%	5.1%	5:22:28	<b>10</b>	8	227	0:01:12	
<b>8</b>	97:30:48	92.5%	4.3%	4:33:04	<b>8</b>	10	90	0:03:35	
<b>6</b>	98:30:09	93.5%	0.9%	0:59:21	<b>6</b>	6	51	0:01:10	
<b>5</b>	98:37:32	93.6%	0.1%	0:07:23	<b>5</b>	5	13	0:00:34	

Table 19. CMMC PRE: Details by Process.

CMMC POST (N = 26 observations - RN):

<b>Nurse Shadowing: Study Time Period = POST, Location = MMC</b>									
<b>Processes ranked by Total Time per PID</b>						<b>PID ranked by Count</b>			
<b>PID</b>	<i>cumulative time, hh:mm:ss</i>	<i>cumulative % of time</i>	<i>% of Total Time per PID</i>	<b>Total Time / PID, hh:mm:ss</b>	<b>PID</b>	<b>PID</b>	<b>Count of Activity IDs</b>	<i>avg. time / AID, hh:mm:ss</i>	
<b>1</b>	22:10:21	21.1%	21.1%	22:10:21	<b>1</b>	7	1261	0:00:33	
<b>2</b>	41:42:02	39.8%	18.6%	19:31:41	<b>2</b>	1	1249	0:01:04	
<b>4</b>	60:07:50	57.3%	17.6%	18:25:48	<b>4</b>	4	1109	0:01:00	
<b>3</b>	72:12:12	68.8%	11.5%	12:04:22	<b>3</b>	9	598	0:00:55	
<b>7</b>	83:46:53	79.9%	11.0%	11:34:41	<b>7</b>	3	491	0:01:29	
<b>9</b>	92:56:34	88.6%	8.7%	9:09:41	<b>9</b>	2	363	0:03:14	
<b>8</b>	98:28:14	93.9%	5.3%	5:31:40	<b>8</b>	8	221	0:01:30	
<b>10</b>	100:57:21	96.2%	2.4%	2:29:07	<b>10</b>	10	39	0:03:49	
<b>6</b>	101:05:17	96.4%	0.1%	0:07:56	<b>6</b>	6	8	0:00:59	
<b>5</b>	101:07:23	96.4%	0.0%	0:02:06	<b>5</b>	5	3	0:00:42	

Table 20. CMMC POST: Details by Process.

Meyersdale Medical Center (MYMC)

MYMC PRE (N = 1 observation - LPN):

<b><i>Nurse Shadowing: Study Time Period = PRE, Location = MYMC</i></b>								
<b>Processes ranked by Total Time per PID</b>						<b>PID ranked by Count</b>		
<b>PID</b>	<i>cumulative time, hh:mm:ss</i>	<i>cumulative % of time</i>	<i>% of Total Time per PID</i>	<b>Total Time / PID, hh:mm:ss</b>	<b>PID</b>	<b>PID</b>	<b>Count of Activity IDs</b>	<i>avg. time / AID, hh:mm:ss</i>
<b>10</b>	1:06:28	28.3%	28.3%	1:06:28	<b>10</b>	1	35	0:00:55
<b>3</b>	1:53:05	48.1%	19.8%	0:46:37	<b>3</b>	7	17	0:00:41
<b>4</b>	2:27:58	63.0%	14.8%	0:34:53	<b>4</b>	4	16	0:02:11
<b>1</b>	3:00:04	76.6%	13.7%	0:32:06	<b>1</b>	3	7	0:06:40
<b>7</b>	3:11:43	81.6%	5.0%	0:11:39	<b>7</b>	10	6	0:11:05
<b>9</b>	3:20:48	85.4%	3.9%	0:09:05	<b>9</b>	9	5	0:01:49
<b>2</b>	3:23:09	86.4%	1.0%	0:02:21	<b>2</b>	8	2	0:00:54
<b>8</b>	3:24:57	87.2%	0.8%	0:01:48	<b>8</b>	2	1	0:02:21
<b>5</b>	3:25:23	87.4%	0.2%	0:00:26	<b>5</b>	5	1	0:00:26
<b>6</b>	3:25:23	87.4%	0.0%	0:00:00	<b>6</b>	6	0	

Table 21. MYMC PRE: Details by Process.

MYMC POST (N = 1 observation - LPN):

<b><i>Nurse Shadowing: Study Time Period = POST, Location = MYMC</i></b>								
<b>Processes ranked by Total Time per PID</b>						<b>PID ranked by Count</b>		
<b>PID</b>	<i>cumulative time, hh:mm:ss</i>	<i>cumulative % of time</i>	<i>% of Total Time per PID</i>	<b>Total Time / PID, hh:mm:ss</b>	<b>PID</b>	<b>PID</b>	<b>Count of Activity IDs</b>	<i>avg. time / AID, hh:mm:ss</i>
<b>3</b>	1:42:04	39.9%	39.9%	1:42:04	<b>3</b>	7	44	0:00:48
<b>1</b>	2:40:13	62.6%	22.7%	0:58:09	<b>1</b>	4	28	0:00:59
<b>7</b>	3:15:08	76.2%	13.6%	0:34:55	<b>7</b>	1	22	0:02:39
<b>4</b>	3:42:51	87.1%	10.8%	0:27:43	<b>4</b>	3	10	0:10:12
<b>9</b>	3:58:57	93.4%	6.3%	0:16:06	<b>9</b>	9	4	0:04:01
<b>2</b>	3:58:57	93.4%	0.0%	0:00:00	<b>2</b>	2	0	
<b>5</b>	3:58:57	93.4%	0.0%	0:00:00	<b>5</b>	5	0	
<b>6</b>	3:58:57	93.4%	0.0%	0:00:00	<b>6</b>	6	0	
<b>8</b>	3:58:57	93.4%	0.0%	0:00:00	<b>8</b>	8	0	
<b>10</b>	3:58:57	93.4%	0.0%	0:00:00	<b>10</b>	10	0	

Table 22. MYMC POST: Details by Process.

## Appendix 5 – VLER Patient Letter



Conemaugh  
Health System

James E. Van Zandt  
VA Medical Center



Dear Veteran,

There is a new way to share information with your healthcare providers in southwestern Pennsylvania!

The Virtual Lifetime Electronic Record (VLER) health program will allow you to share your electronic health information, via the Nationwide Health Information Network (NwHIN), with your providers who are members of the Conemaugh Health System and the James E. Van Zandt VA Medical Center in Altoona, PA.

We invite you to sign up for the VLER Health program by completing and signing the enclosed forms. After you join, your health care providers will be able to see your current medical issues, emergency room reports, discharge summaries, medications, allergies, and other important information in your medical record as necessary for your treatment. This information will be used to improve the care you receive from your providers, and avoid duplicating services. Access to your information will be strictly controlled and protected using data security standards commonly used in the banking industry.

Once you have completed and signed the forms we have included, please return them in the envelope provided. Signing these forms means that you are agreeing to share your health information among health care providers in the NwHIN Exchange who provide your medical treatment.

If you have questions, please contact:

John Hargreaves, Conemaugh Health System, at (814) 269-5277, and/or  
Barbara Babiak, VLER Coordinator, James E. Van Zandt VA Medical Center, at (814) 943-8164 Ext. 8022.

We are proud to serve Veterans that served our country!

Scott Becker  
Chief Executive Officer  
Conemaugh Health System

William Mills  
Medical Center Director  
James E. Van Zandt VA Medical Center

*If you decide not to join, do nothing. Your health record will not be shared with private healthcare facilities using this program. Your choice will not affect the care you receive from your providers, your future care at the VA, or your VA benefits. If you choose to join now and later change your mind, please contact the VA Release of Information Office at (814) 943-8164 Ext. 8022.*



**Certification Commission  
for Health Information  
Technology**

# eHealth Exchange Participant Testing Test Summary Report – 2010 & 2011

## **Conemaugh Health System**

10/25/2013

### Document Change History

Version Nbr	Date	Change Description	Changed By
1.0	10/25/2013	Initial Report for 2010	Heather Geier, CCHIT
1.1	10/25/2013	Merged Report for 2010 & 2011 (Initial Report for 2011)	Heather Geier, CCHIT

## Summary Report Overview

Date of completion	September 3, 2013
For	Conemaugh Health System
Applicant Primary contact	John Hargreaves <a href="mailto:jhargrea@conemaugh.org">jhargrea@conemaugh.org</a> (814) 269-5277
Gateway Implementation Technology Vendor, if applicable	Northrop Grumman Information Systems
Gateway Name and Version	CONNECT 3.3.1.3
Scope of testing	<p>Conemaugh Health System tested 2010 and 2011 versions for eHealth Exchange Participant Testing.</p> <p>Testing validated adherence to the following eHealth Exchange specifications (unless otherwise noted):</p> <ul style="list-style-type: none"> <li>• Patient Discovery, version 1.0 (2010) &amp; version 2.0 (2011)</li> <li>• Query for Documents, version 2.0 (2010) &amp; version 3.0 (2011)</li> <li>• Retrieve Documents, version 2.0 (2010) &amp; version 3.0 (2011)</li> <li>• Messaging Platform, version 2.0 (2010) &amp; version 3.0 (2011)</li> <li>• Authentication Framework, version 2.0 (2010) &amp; version 3.0 (2011)</li> </ul>
Summary of test results	PASS: Conemaugh Health System successfully completed and passed eHealth Exchange Participant Testing for 2010 & 2011, with the exception of known issues with the CONNECT gateway for versions lower than 4.0.

## Test Results Summary

### 2010 Version

#### Smoke Test Cases

Service Set	Scenario	Test Case	Status	Analysis/Notes
SS: PRL-0000.0-2010	TS: PRL-I-0000.0-2010	TC: PD-I-0000.0-2010	PASS	
SS: PRL-0000.0-2010	TS: PRL-I-0000.0-2010	TC: QD-I-0000.0-2010	PASS	
SS: PRL-0000.0-2010	TS: PRL-I-0000.0-2010	TC: RD-I-0000.0-2010	PASS	
SS: PRL-0000.0-2010	TS: PRL-R-0000.0-2010	TC: PD-R-0000.0-2010	PASS	
SS: PRL-0000.0-2010	TS: PRL-R-0000.0-2010	TC: QD-R-0000.0-2010	PASS	
SS: PRL-0000.0-2010	TS: PRL-R-0000.0-2010	TC: RD-R-0000.0-2010	PASS	

### 2011 Version

#### Smoke Test Cases

Service Set	Scenario	Test Case	Status	Analysis/Notes
SS: PRL-0000.0-2011	TS: PRL-I-0000.0-2011	TC: PD-I-0000.0-2011	PASS*	*Manually override status to a Pass with a reason of “Failing only because SSN was part of message. SSN was verified to be sent correctly”
SS: PRL-0000.0-2011	TS: PRL-I-0000.0-2011	TC: QD-I-0000.0-2011	PASS	
SS: PRL-0000.0-2011	TS: PRL-I-0000.0-2011	TC: RD-I-0000.0-2011	PASS	
SS: PRL-0000.0-2011	TS: PRL-R-0000.0-2011	TC: PD-R-0000.0-2011	PASS	
SS: PRL-0000.0-2011	TS: PRL-R-0000.0-2011	TC: QD-R-0000.0-2011	PASS	
SS: PRL-0000.0-2011	TS: PRL-R-0000.0-2011	TC: RD-R-0000.0-2011	PASS	

#### Security Test Cases

Service Set	Scenario	Test Case	Status	Analysis/Notes
SS: PRL-0006.0-2011	TS: PRL-R-0006.0-2011	TC: MAQD-R-0003.000-2011	PASS	
SS: PRL-0006.0-2011	TS: PRL-R-0006.0-2011	TC: MAQD-R-0003.101-2011	PASS	
SS: PRL-0006.0-2011	TS: PRL-R-0035.0-2011	TC: MAQD-R-0003.301-2011	PASS*	*Manually override status to a Pass with a reason of “Known Issue”
SS: PRL-0006.0-2011	TS: PRL-R-0036.0-2011	TC: MAQD-R-0003.302-2011	PASS	
SS: PRL-0006.0-2011	TS: PRL-R-0036.0-2011	TC: MAQD-R-0003.303-2011	PASS	
SS: PRL-0006.0-2011	TS: PRL-R-0037.0-2011	TC: MAQD-R-0003.306-2011	PASS	

SS: PRL-0006.0-2011	TS: PRL-R-0037.0-2011	TC: MAQD-R-0003.307-2011	PASS	
SS: PRL-0006.0-2011	TS: PRL-R-0038.0-2011	TC: MAQD-R-0003.308-2011	PASS	
SS: PRL-0011.0-2011	TS: PRL-R-0040.0-2011	TC: MAQD-R-0003.315-2011	PASS	
SS: PRL-0011.0-2011	TS: PRL-R-0040.0-2011	TC: MAQD-R-0003.316-2011	PASS	
SS: PRL-0011.0-2011	TS: PRL-R-0041.0-2011	TC: MAQD-R-0003.317-2011	PASS	
SS: PRL-0011.0-2011	TS: PRL-R-0043.0-2011	TC: MAQD-R-0003.325-2011	PASS	
SS: PRL-0011.0-2011	TS: PRL-R-0044.0-2011	TC: MAQD-R-0003.326-2011	PASS	
SS: PRL-0012.0-2011	TS: PRL-R-0046.0-2011	TC: MAQD-R-0003.401-2011	PASS	
SS: PRL-0013.0-2011	TS: PRL-R-0052.0-2011	TC: MAQD-R-0003.421-2011	PASS*	*Manually override status to a Pass with a reason of “Known Issue”
SS: PRL-0013.0-2011	TS: PRL-R-0053.0-2011	TC: MAQD-R-0003.423-2011	PASS	
SS: PRL-0013.0-2011	TS: PRL-R-0053.0-2011	TC: MAQD-R-0003.424-2011	PASS*	*Manually override status to a Pass with a reason of “Known Issue”
SS: PRL-0013.0-2011	TS: PRL-R-0054.0-2011	TC: MAQD-R-0003.426-2011	PASS	
SS: PRL-0013.0-2011	TS: PRL-R-0054.0-2011	TC: MAQD-R-0003.427-2011	PASS	

## References

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<sup>1</sup> Hassink J, Jansen M, Helmons P. Effects of bar code-assisted medication administration (BCMA) on frequency, type, and severity of medication administration errors: a review of the literature. *European Journal of Hospital Pharmacy*. 2012;19:489-494.

<sup>2</sup> Poon EG, Keohane CA, Yoon CS et al. Effect of bar-code technology on the safety of medication administration. *New England Journal of Medicine*. 2010;362: 1698-1707.

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